Aſpirate | Aſſaron.

ſubſtantial proofs of his charity. Being very old, he uſed to ride on a mule through the city, and relieved all the poor he met; to which his mule was ſo well accuſtomed, that it ſtopped of its own accord at the ſight of every poor man till its maſter had relieved him. He refuſed ſeveral honourable poſts in church and ſtate, that he might have leiſure to correct and improve the works he had already written, and compoſe others. He died at the age of 94, on the 21ſt of June 1586. He wrote a vaſt number of treatiſes, all which are either on morality or canon law.

ASPIRATE, in grammar, denotes words marked with the ſpiritus aſper. See ASPER.

ASPIRATION, among grammarians, is uſed to denote the pronouncing a ſyllable with ſome vehemence.

ASPLENIUM, CETERACH: A genus of the order of filices, belonging to the cryptogamia claſs of plants. The parts of fructification are ſituated in the ſmall ſparſe line under the diſk of the leaves. There are 24 ſpecies. Two of theſe are natives of Britain, and grow upon old walls or moiſt rocks; one is called *ſcolopendrium*, or *hart's tongue*: the other is properly *ceterach*, alſo called *ſpleenwort*. It has an herbaceous, ſomewhat mucilaginous, roughiſh taſte: it is recommended as a pectoral, and for promoting urine in nephritic caſes. The virtue which it has been moſt celebrated for is that which it has the leaſt title to, viz. diminiſhing the ſpleen.

ASS, in zoology, is ranked as a ſpecies of equus, or horſe. See EQUUS.

Coronation of the Ass, in antiquity, was a part of the ceremony of the feaſt of Veſta, wherein the bakers put bread crowns on the heads of theſe quadrupeds; * *Ecce coronatis panis dependet aſellis* *. Hence, in an ancient calendar, the ides of June are thus denoted: *Feſtum eſt Veſtæ. Aſinus coronatur!*—This honour, it ſeems was done the beaſt, becauſe, by its braying, it had ſaved Veſta from being raviſhed by the Lampſacan god. Hence the formula, *Veſtæ delicium eſt aſinus*.

* Ovid Faſt. vi. 311.

ASSAI, in muſic, ſignifies quick; and, according to others, that the motion of the piece be kept in a middle degree of quickneſs or ſlowneſs. As, *Aſſai allegro, aſſai preſto*. See ALLEGRO and PRESTO.

ASSANCALA, a ſtrong town in Armenia, near the river Arras, in the road between Erzerum and Erivan, and noted for its hot baths. It ſtands on a high hill; the walls are built in a ſpiral line all round the rock and ſtrengthened with ſquare towers. The ditches are about two fathoms over, cut out of hard rock. E. Long. 41. 30. N. Lat. 39. 46.

ASSANCHIF, a town of Aſia, in Diarbekir, ſeated on the river Tigris. E. Long. 42. 30. N. Lat. 37. 20.

ASSANS. See ASSENS.

ASSARIUM, in antiquity, denotes a ſmall copper coin, being a part or diminutive of the *as*. The word ασσαριον is uſed by Suidas indifferently with οβολος and νομισμα, to denote a ſmall piece of money; in which he is followed by Cujacius, who defines ασσαριον by *Minimus æris nummus*. We find mention of the aſſarion in the goſpel of St Matthew, chap. x. verſe 29.

ASSARON, or OMER, a meaſure of capacity, in uſe among the Hebrews, containing five pints. It the meaſure of manna which God appointed for every Iſraelite.

Aſſaſin, Aſſaſſins.

ASSASIN, or ASSASSIN, a perſon who kills another with the advantage either of an inequality in the weapons, or by means of the ſituation of the place, or by attacking him at unawares.

The word *aſſaſſin* is ſaid by ſome to have been brought from the Levant, where it took its riſe from a certain prince of the family of the *Arſacidæ*; popularly called *Aſſaſſins*, living in a caſtle between Antioch and Damaſco, and bringing up a number of young men, ready to pay a blind obedience to his commands; whom he employed in murdering the princes with whom he was at enmity. But according to Mr Volney, the word *Haſſaſſin* (from the root *haſs*, "to kill, aſſaſſinate, to liſten, to ſurpriſe,") in the vulgar Arabic ſignifies "Robbers of the night," perſons who *lie in ambuſh to kill*; and is univerſally underſtood in this ſenſe at Cairo and in Syria. Hence it was applied to the *Batenians*, who ſlew by ſurpriſe. See the next article.

There was a certain law of nations, an opinion received in all the republics of Greece and Italy, whereby he that aſſaſſinated an uſurper of the ſupreme power was declared a virtuous man. At Rome eſpecially, after the expulſion of the kings, the law was formal and ſolemn, and inſtances of it admitted. The commonwealth armed the hand of any citizen, and created him magiſtrate for that moment.

ASSASSINS, a tribe or clan in Syria, called alſo *Iſmaelians* and *Bataniſts* or *Batenians*. Theſe people probably owed their origin to the Kirmatians, a famous heretical ſect among the Mahometans, who ſettled in Perſia about the year 1090; whence, in proceſs of time, they ſent a colony into Syria, where they became poſſeſſed of a conſiderable tract of land among the mountains of Lebanon, extending itſelf from the neighbourhood of Antioch to Damaſcus.

The firſt chief and legiſlator of this remarkable tribe appears to have been Haſſan Sabah, a ſubtle impoſtor, who by his artifices made fanatical and implicit ſlaves of his ſubjects. Their religion was compounded of that of the Magi, the Jews, the Chriſtians, and the Mahometans: but the capital article of their creed was to believe that the Holy Ghoſt reſided in their chief; that his orders proceeded from God himſelf, and were real declarations of his divine pleaſure. To this monarch the orientals gave the name of *Scheik*: but he is better known in Europe by the name of the *Old Man of the Mountain*. His dignity, inſtead of being hereditary, was confirmed by election; where merit, that is, a ſuperior multiplicity and enormity of crimes, was the moſt effectual recommendation to a majority of ſuffrages.

This chief, from his exalted reſidence on the ſummit of mount Lebanon, like a vindictive deity, with the thunderbolt in his hand, ſent inevitable death to all quarters of the world; ſo that from one end of the earth to the other, kalifs, emperors, ſultans, kings, princes, Chriſtians, Mahometans, and Jews, every nation and people, execrated and dreaded his ſanguinary power, from the ſtrokes of which there was no ſecurity. At the leaſt ſuggeſtion or whiſper that he had threatened the death of any potentate, all immediately doubled their guards, and took every other precaution in their

Aſſaſſins. power. It is known that Philip Auguſtus king of France, on a premature advice that the Scheik intended to have him aſſaſſinated, inſtituted a new body-guard of men diſtinguiſhed for their activity and courage, called *ſergens d'Armes*, with braſs clubs bows and arrows; and he himſelf never appeared without a club, fortified either with iron or gold. Moſt ſovereigns paid ſecretly a penſion to the Scheik, however ſcandalous and derogatory it might be to the luſtre of majeſty, for the ſafety of their perſons. The Knights Templars alone dared to defy his ſecret machinations and open force. Indeed they were a permanent diſperſed body, not to be cut off by maſſacres or aſſaſſinations.

This barbarous prince was furniſhed with reſources unknown to all other monarchs even to the moſt abſolute deſpotic tyrant. His ſubjects would proſtrate themſeves at the foot of his throne, requeſting to die by his hand or order, as a favour by which they were ſure of paſſing in paradiſe. On them if danger made any impreſſion, it was an emulation to preſs forward; and if taken in any enterpriſe, they went to the place of execution with a magnanimity unknown to others. Henry count of Champaigne, who married Iſabella daughter of Amaury king of Jeruſalem, paſſing over part of the territory of the Aſſaſſins in his way to Syria, and talking highly of his power, their chief came to meet him, "Are your ſubjects (ſaid the old man of the mountain) as ready in their ſubmiſſion as mine?" and, without ſtaying for an anſwer, made a ſign with his hand, when ten young men in white, who were ſtanding on an adjacent tower, inſtantly threw themſelves down. On another occaſion, Sultan Malek-Shah ſummoning the Scheik to ſubmit himſelf to his government, and threatening him with the power of his arms, ſhould he heſitate to comply; the latter, very compoſedly turning himſelf towards his guards, ſaid to one of them, "Draw your dagger and plunge it into your breaſt;" and to another, "Throw yourſelf headlong from yonder rock." His orders were no ſooner uttered than they were joyfully obeyed: and all the anſwer he deigned to give the ſultan's envoy was, "Away to thy maſter, and let him know I have many thouſand ſubjects of the ſame diſpoſition." Men ſo ready to deſtroy themſelves were equally alert and reſolute in being the miniſters of death to others. At the command of their ſovereign, they made no difficulty of ſtabbing any prince, even on his throne; and being well verſed in the different dialects, they conformed to the dreſs and even the external religion of the country, that they might with leſs difficulty ſtrike the fatal blow required by their chief. With the Saracens they were Mahometans; with the Franks, Chriſtians; in one place they joined with the Mamaluks; in another, with the eccleſiaſtics or religious; and under this diſguiſe ſeized the firſt opportunity of executing their ſanguinary commiſſion. Of this we meet with an inſtance in the hiſtory of Saladin, while he was beſieging Manbedge, the celebrated Hieropolis of antiquity. Being one day, with a few attendants, and they at ſome diſtance, reconnoitring the place for the better diſpoſition of the attack, a man ruſhed on him with a dagger in his hand, and wounded him in the head; but the ſultan, as he was endeavouring to repeat his ſtroke, wreſted the dagger from him, and, after receiving ſeveral wounds, laid him dead at his feet. Before the ſultan had well recovered himſelf, a ſecond encountered him to finiſh the treachery of the former; but he met with the ſame fate: he was ſucceeded with equal fury by a third, who alſo fell by the hand of that magnanimous prince whom he was ſent to aſſaſſinate. And it was obſerved, that theſe wretches dealt about their fruitleſs blows as they lay in the agonies of death. With ſuch rapidity was this tranſacted, that it was over before Saladin's guards could come to his aſſiſtance. He retired to his tent, and in great perturbation throwing himſelf on his ſopha, ordered his ſervants to take a ſtrict view of his houſehold, and to caſhier all ſuſpected perſons; at the ſame time aſking with great earneſtneſs, "Of whom have I deſerved ſuch treacherous uſage?" But it afterwards appeared, that theſe villains had been ſent by the old man of the mountain; of whom the vizir Kamſchlegin had purchaſed the murder of Saladin, to free himſelf from ſo great a warrior whom he could not meet in the field. To animate them in their frantic obedience, the Scheik, before their departure on ſuch attempts, uſed to give them a ſmall foretaſte of ſome of the delights which he aſſured them would be their recompenſe in paradiſe. Delicious ſoporific drinks were given them; and while they lay aſleep, they were carried into beautiful gardens, where very allurement invited their ſenſes to the moſt exquiſite gratifications. From theſe ſeats of voluptuouſneſs, inflamed with liquor and enthuſiaſtic views of perpetual enjoyments, they ſallied forth to perform aſſaſſinations of the blackeſt dye.

Aſſaſſins || Aſſar.

This people once had, or atleaſt they feigned to have, an intention of embracing the Chriſtian religion. They reigned a long time in Perſia and on Mount Lebanon. Hulaku, a khan of the Mogul Tartars, in the year 655 of the Hegira, or 1254 of the Chriſtian æra, entered their country and diſpoſſeſſed them of ſeveral places; but it was not till the year 1272 that they were totally conquered. This atchievement was owing to the conduct and intrepidity of the Epyptian forces ſent againſt them by the ſultan Bibaris. It has, however, been thought that the Druſes, who ſtill reſide among the eminences of Mount Lebanon, and whoſe religion and cuſtoms are ſo little known, are a remnant of thoſe barbarians.

ASSAULT, in law, is an attempt or offer to beat another, without touching him: as if one lifts up his cane or his fiſt in a threatening manner at another; or ſtrikes at him, but miſſes him; this is an aſſault, *inſultus*, which Finch deſcribes to be "an unlawful ſetting upon one's perſon." This alſo is an inchoate violence, amounting conſiderably higher than bare threats; and therefore, though no actual ſuffering is proved, yet the party injured may have redreſs by action of *treſpaſs vi et armis*, wherein he ſhall recover damages as a compenſation for the injury.

ASSAULT, in the military art, a furious effort made to carry a fortified poſt, camp, or fortreſs, wherein the aſſailants do not ſcreen themſelves by any works: while the aſſault continues, the batteries ceaſe, for fear of killing their own men.—The *enfans perdus* march firſt to the aſſault. See *ENFANS Perdus*.

ASSAY, ESSAY, or SAY, in metallurgy, the proof or trial of the goodneſs, purity, value, &c. of metals and metalline ſubſtances. See ESSAY.

BRITISH MUSEUM

Aſſaying, Aſſay.

In ancient ſtatutes this is called *touch*; and thoſe who had the care of it, *Keepers of the touch*.—Under Henry VI. divers cities were appointed to have touch for wrought ſilver-plate, 2 Hen. VI. c. 14.—By this, one might imagine they had no better method of aſſaying than the ſimple one by the touch-ſtone; but the caſe is far otherwiſe. In the time of King Henry II. the biſhop of Saliſbury, then treaſurer, conſidering that though the money paid into the king's exchequer for his crown-rents did anſwer *numero et pondere*, it might nevertheleſs be mixed with copper or braſs: wherefore a conſtitution was made, called the *trial by combuſtion*; which differs little or nothing from the preſent method of aſſaying ſilver. See a deſcription of it in the Black Book in the Exchequer, written by Gervaſe of Tilbury, c. xxi. This trial is alſo there called *eſſaium*, and the officer who made it is named *fuſor*. The method ſtill in uſe of aſſaying gold and ſilver was firſt eſtabliſhed by an act of the Engliſh parliament 1354.

ASSAYING, *ars docimaſtica*, in its extent, comprehends particular manners of examining every ore, or mixed metal, according to its nature, with the beſt-adapted fluxes; ſo as to diſcover, not only what metals, and what proportions of metal, are contained in ores; but likewiſe how much ſulphur, vitriol, alum, arſenic, ſmelt, &c. may be obtained from every one reſpectively. See BLOW-PIPE, METALLURGY, and MINERALOGY.

Aſſaying is more particularly uſed by moneyers and goldſmiths, for the making a proof or trial by the cuppel, or teſt, of the fineneſs or purity of the gold and ſilver to be uſed in the coining of money, and manufacture of plate, &c. or that have been already uſed therein.

There are two kinds of aſſaying; the one before metals are melted, in order to bring them to their proper fineneſs; the other after they are ſtruck, to ſee that the ſpecies be ſtandard. For the firſt aſſay, the aſſayers uſe to make 14 or 15 grains of gold, and half a dram of ſilver, if it be for money; and 18 grains of the one, and a dram of the other, if for other occaſions. As to the ſecond aſſay, it is made of one of the pieces of money already coined, which they cut in four parts. The quantity of gold for an aſſay among us is ſix grains: In France, nearly the ſame; and in Germany, about three times as much.

The proper ſpelling of that word, however, is ESSAY; under which article, therefore, the reader will find the ſubject more particularly treated.

Assay-Balance, or *Eſſay-Balance*, the flat pieces of glaſs often placed under the ſcales of an aſſay-balance, ſeem, by their power of electricity, capable of attracting, and thereby making the lighter ſcale preponderate, where the whole matter weighed is ſo very ſmall. See *Eſſay-BALANCE*.

The electricity of a flat ſurface of about three inches ſquare has been known to hold down one ſcale, when there were about 200 grains weight in the other. See BALANCE.

Assay-Maſter, or *Eſſay-Maſter*, an officer under certain corporations entruſted with the care of making true touch, or aſſay, of the gold and ſilver brought to him; and giving a juſt report of the goodneſs or badneſs thereof. Such is the aſſay-maſter of the mint in the Tower, called alſo *aſſayer of the king*.

Aſſelyn Aſſemblies.

The aſſay-maſter of the goldſmiths company is a ſort of aſſiſtant-warden, called alſo a *touch-warden*, appointed to ſurvey, aſſay, and mark all the ſilver-work, &c. committed to him. There are alſo aſſay-maſters appointed by ſtatute at York, Exeter, Briſtol, Cheſter, Norwich, Newcaſtle, and Birmingham, for aſſaying wrought plate. The aſſay-maſter is to retain eight grains of every pound Troy of ſilver brought to him; four whereof are to be put in the pix, or box of deal, to be re-aſſayed the next year, and the other four to be allowed him for his waſte and ſpillings.

Note, The number of pennyweights ſet down in the aſſay-maſter's report, is to be accounted as per pound, or ſo much in every pound of 12 ounces Troy. For every 20 penny-weight, or ounce Troy, the ſilver is found by the aſſay to be worſe than ſtandard, or ſterling, ſixpence is to be deducted; becauſe every ounce will coſt ſo much to reduce it to ſtandard goodneſs, or to change it for ſterling.

In gold, for every carat it is ſet down to be worſe than ſtandard, you muſt account that in the ounce Troy it is worſe by ſo many times 3 s. 8 d.; and for every grain it is ſet down worſe, you muſt account it worſe by ſo many times 11 d. in the ounce Troy; and for every half grain 5½ d.: for ſo much it will coſt to make it of ſtandard goodneſs, &c.

ASSELYN (John), a famous Dutch painter, was born in Holland, and became the diſciple of Iſaiah Vandevelde, the battle-painter. He diſtinguiſhed himſelf in hiſtory-paintings, battles, landſcapes, animals, and particularly horſes. He travelled into France and Italy; and was ſo pleaſed with the manner of Bambochio, that he always followed it. He painted many pictures at Lyons, where he married the daughter of a merchant of Antwerp, and returned with her to Holland. Here he firſt diſcovered to his countrymen a freſh and clear manner of painting landſcapes, like Claude Lorraine; upon which all the painters imitated his ſtyle, and reformed the dark brown they had hitherto followed. Aſſelyn's pictures were ſo much admired at Amſterdam, that they ſold there at a high price. He died in that city in 1660. Twenty-four pieces of landſcapes and ruins, which he painted in Italy, have been engraved by Perelle.

ASSEMBLAGE, the uniting or joining of things together; or the things themſelves ſo united or joined. It is alſo uſed, in a more general ſenſe, for a collection of various things ſo diſpoſed and diverſified, that the whole produces ſome agreeable effect.

ASSEMBLY, the meeting of ſeveral perſons, in the ſame place, upon the ſame deſign.

ASSEMBLY, in the beau monde, an appointed meeting of faſhionable perſons of both ſexes, for the ſake of play, dancing, gallantry, converſation, &c.

ASSEMBLY, in the military art, the ſecond beating of a drum before a march; at which the ſoldiers ſtrike their tents, roll them up, and ſtand to arms.

ASSEMBLIES of the clergy are called *convocations*, *ſynods*, *councils*. The annual meeting of the church of Scotland is called a *General Aſſembly*: In this aſſembly his Majeſty is repreſented by his Commiſſioner, who diſſolves one meeting, and calls another, in the name of the *King*, while the Moderator does the ſame in the name of the *Lord Jeſus Chriſt*.

ASSEMBLIES of the Roman people were called *comitia*.

Aſſens
Aſſets.

Under the Gothic governments, the ſupreme legiſlative power was lodged in an aſſembly of the ſtates of the kingdom, held annually for the like purpoſes as the Britiſh parliament. Some feeble remains of this uſage ſtill ſubſiſt in the annual aſſemblies of the ſtates of Languedoc, Bretagne, and a few other provinces of France; but theſe are no more than ſhadows of the ancient aſſemblies. It is only in Great Britain, Sweden, and Poland, that ſuch aſſemblies retain their ancient powers and privileges.

ASSENS, a ſea-port town of Denmark, ſituated upon the Little Belt, a ſtrait of the Baltic, which ſeparates the iſle of Funen from the continent. It is the common paſſage from the duchy of Sleſwick to Copenhagen. E. Long. 10. 30. N. Lat. 55. 15.

ASSENT, in a general ſenſe, implies an agreement to ſomething propoſed or affirmed by another.

Royal ASSENT, the approbation given by the king to a bill in parliament, after which it becomes a law.

ASSER (John), or ASSERIUS MENEVENSIS, that is, *Aſſer of St David's*, biſhop of Shirburn in the reign of Alfred the Great. He was born in Pembrokeſhire, in South Wales; and educated in the monaſtery of St David's by the archbiſhop Aſſerius, who, according to Leland, was his kinſman. In this monaſtery he became a monk, and by his aſſiduous application ſoon acquired univerſal fame as a perſon of profound learning and great abilities. Alfred, the munificent patron of genius, about the year 880, ſent for him to court. The king was then at Dean in Wiltſhire. He was ſo charmed with Aſſer, that he made him his preceptor and companion. As a reward for his ſervices, he appointed him abbot of two or three different monaſteries; and at laſt promoted him to the epiſcopal ſee of Shirburn, where he died and was buried in the year 910. He was, ſays Pits, a man of a happy genius, wonderful modeſty, extenſive learning, and great integrity of life. He is ſaid to have been principally inſtrumental in perſuading the king to reſtore the univerſity of Oxford to its priſtine dignity and luſtre.—He wrote, *De vita et rebus geſtis Alfredi*, &c. Lond. 1574, publiſhed by Archbiſhop Parker, in the old Saxon character, at the end of *Walſinghami hiſt.*——Francf. 1602. fol. Oxf. 1722, 8vo. Many other works are aſcribed to this author by Gale, Bale, and Pits, but all doubtful.

ASSERIA. See ASISIA.

ASSERTION, in the language of the ſchools, a propoſition advanced by the aſſertor, who avows the truth of it, and is ready to defend it.

ASSESSOR, an inferior officer of juſtice, appointed chiefly to aſſiſt the ordinary judge with his opinion and advice.

ASSESSOR is alſo one who aſſeſſes or ſettles taxes and other public dues.

ASSETS, in law, ſignifies goods enough to diſcharge that burden which is caſt upon the executor or heir, in ſatisfying the debts and legacies of the teſtator or anceſtor. Aſſets are real or perſonal. Where a man hath lands in fee ſimple, and dies ſeiſed thereof, the lands which come to his heir are aſſets real; and where he dies poſſeſſed of any perſonal eſtate, the goods which come to the executors are aſſets perſonal. Aſſets are alſo divided into *aſſets per deſcent*, and *aſſets inter maines*. Aſſets by deſcent is where a perſon is bound in an obligation, and dies ſeiſed of lands which deſcend to the heir, the land ſhall be aſſets, and the heir ſhall be charged as far as the land to him deſcended will extend. *Aſſets inter maines* is when a man indebted makes executors, and leaves them ſufficient to pay his debts and legacies; or where ſome commodity or profit ariſeth to them in right of the teſtator, which are called *aſſets in their hands*.

Aſſeveration
Aſſiento.

ASSEVERATION, a poſitive and vehement affirmation of ſomething.

ASSHETON (William), doctor of divinity, and rector of Beckenham, in Kent, was born in the year 1641, and was educated at Brazen-noſe college, Oxford. After entering into orders, he became chaplain to the Duke of Ormond, and was admitted doctor of divinity in 1673. Soon after, he was nominated to a prebend in the church of York, preſented to the living of St Antholin, London, and to the rectory of Beckenham in Kent. He was the firſt projector of the ſcheme for providing for clergymens widows, and others, by a jointure payable out of the mercers company. He wrote ſeveral pieces againſt the Papiſts and Diſſenters, and ſome devotional tracts. He died at Beckenham in September 1711, in the 70th year of his age.

ASSIDEANS, or CHASSIDÆANS, (from the Hebrew *chaſidim*, "merciful, pious"); thoſe Jews who reſorted to Mattathias to fight for the law of God and the liberties of their country. They were men of great valour and zeal, having voluntarily devoted themſelves to a more ſtrict obſervation of the law than other men. For, after the return of the Jews from the Babyloniſh captivity, there were two ſorts of men in their church; thoſe who contented themſelves with that obedience only which was preſcribed by the law of Moſes, and who were called *Zadikim*, i. e. the *righteous*; and thoſe who, over and above the law, ſuperadded the conſtitutions and traditions of the elders, and other rigorous obſervances: theſe latter were called *Chaſidim*, i. e. the *pious*. From the former ſprung the Samaritans, Sadducees, and Caraites; from the latter, the Phariſees and the Eſſenes.

ASSIDENT SIGNS, in medicine, are ſymptoms which uſually attend a diſeaſe but not always; hence differing from *pathognomic* ſigns, which are inſeparable from the diſeaſe: *e. gr.* In the pleuriſy, a pungent pain in the ſide; in an acute fever, difficulty of breathing, &c. collectively taken, are pathognomic ſigns; but that the pain extends to the hypochondrium or clavicle, or that the patient lies with more eaſe on one ſide than on the other, are *aſſident* ſigns.

ASSIDUUS, or ADSIDUUS, among the Romans, denoted a rich or wealthy perſon. The word in this ſenſe is derived from *as aſſis*, q. d. a monied man. Hence we meet with *aſſiduous* ſureties, *aſſidui ſidejuſſores*; anſwering to what the French now call city ſureties or ſecurities, *cautions bourgeois*.

When Servius Tullius divided the Roman people into five claſſes, according as they were aſſeſſed or taxed to the public, the richer ſort who contributed aſſes were denominated *aſſidui*; and as theſe were the chief people of buſineſs who attended all the public concerns, thoſe who were diligent in attendances came to be denominated *aſſidui*.

ASSIENTO, a Spaniſh word ſignifying a *farm*, in commerce, is uſed for a bargain between the king of Spain

Assign 1 Assise.

Spain and other powers, for importing negroes into the Spaniſh dominions in America, and particularly to Buenos Ayres. The firſt aſſiento was made with the French Guinea-company; and, by the treaty of Utrecht, transferred to the Engliſh, who were to furniſh 4800 negroes annually.

ASSIGN, in common law, a perſon to whom a thing is aſſigned or made over.

ASSIGNATION, an appointment to meet. The word is generally underſtood of love-meetings.

ASSIGNEE, in law, a perſon appointed by another to do an act, tranſact ſome buſineſs, or enjoy a particular commodity.

ASSIGNING, in a general ſenſe, implies the making over the right of one perſon to another. In a particular ſenſe, it ſignifies the pointing out of ſomething; as, an error, falſe judgment, or waſte.

ASSIGNMENT, the transferring the intereſt one has in a leaſe, or other thing, to another perſon.

ASSIMILATION, in phyſics, is that motion by which bodies convert other bodies related to them, or at leaſt ſuch as are prepared to be converted, into their own ſubſtance and nature. Thus, flame multiplies itſelf upon oily bodies, and generates new flame; air upon water, and produces new air; and all the parts, as well ſimilar as organical, in vegetables and animals, firſt attract with ſome election or choice, nearly the ſame common or not very different juices for aliment, and afterwards aſſimilate or convert them to their own nature.

ASSISE, in old Engliſh law-books, is defined to be an aſſembly of knights, and other ſubſtantial men, together with a juſtice, in a certain place, and at a certain time: but the word, in its preſent acceptation, implies a court, place or time, when and where the writs and proceſſes, whether civil or criminal, are decided by judge and jury.

All the counties of England are divided into ſix circuits; and two judges are aſſigned by the king's commiſſion, who hold their aſſiſes twice a-year in every county (except London and Middleſex, where courts of *niſi prius* are holden in and after every term, before the chief or other judge of the ſeveral ſuperior courts; and except the four northern counties, where the aſſiſes are taken only once a year) to try by a jury of the reſpective counties the truth of ſuch matters of fact as are then under diſpute in the courts of Weſtminſter-hall. Theſe judges of aſſiſe came into uſe in the room of the ancient juſtices in eyre, *juſticiarii in itinere:* who were regularly eſtabliſhed, if not firſt appointed, by the parliament of Northampton, A. D. 1176, 22 Hen. II. with a delegated power from the king's great court or *aula regia*, being looked upon as members thereof: and they afterwards made their circuit round the kingdom once in ſeven years for the purpoſe of trying cauſes. They were afterwards directed by *magna charta*, c. 12. to be ſent into every county once a-year to take or try certain actions then called *recognitions* or *aſſiſes;* the moſt difficult of which they are directed to adjorn into the court of common pleas to be there determined. The itinerant juſtices were ſometimes mere juſtices of aſſiſe, or of dower, or of gaol-delivery, and the like; and they had ſometimes a more general commiſſion, to determine all manner of cauſes, *juſticiarii ad omnia placita:* but the preſent juſtices of aſſiſe and *niſi prius* are more immediately derived from the ſtatute Weſtm. 2, 13 Edw. I. c. 30. explained by ſeveral other acts, particularly the ſtatute 14 Edw. III. c. 16. and muſt be two of the king's juſtices of the one bench or the other, or the chief baron of the exchequer, or the king's ſergeants ſworn. They uſually make their circuits in the reſpective vacations after Hilary and Trinity terms; aſſiſes being allowed to be taken in the holy time of Lent by conſent of the biſhops at the king's requeſt, as expreſſed in ſtatute Weſtm. 1. 3 Edw. I. c. 51. And it was alſo uſual, during the times of Popery, for the prelates to grant annual licenſes to the juſtices of aſſiſe to adminiſter oaths in holy times: for oaths being of a ſacred nature, the logic of thoſe deluded ages concluded that they muſt be of eccleſiaſtical cognizance. The prudent jealouſy of our anceſtors ordained that no man of law ſhould be judge of aſſiſe in his own county: and a ſimilar prohibition is found in the civil law, which has carried this principle ſo far, that it is equivalent to the crime of ſacrilege, for a man to be governor of the province in which he was born, or has any civil connection. Aſſiſe.

The judges upon their circuits now ſit by virtue of five ſeveral authorities. 1. The commiſſion of the *peace*, in every county of the circuits; and all juſtices of the peace of the county are bound to be preſent at the aſſiſes; and ſheriffs are alſo to give their attendance on the judges, or they ſhall be fined. 2. A commiſſion of *oyer* and *terminer*, directed to them and many other gentlemen of the county, by which they are empowered to try treaſons, felonies, &c. and this is the largeſt commiſſion they have. 3. A commiſſion of general *gaol-delivery*, directed to the judges and the clerk of aſſiſe aſſociate, which gives them power to try every priſoner in the gaol committed for any offence whatſoever, but none but priſoners in the gaol; ſo that one way or other they rid the gaol of all the priſoners in it. 4. A commiſſion of *aſſiſe*, directed to the judges and clerk of aſſiſe, to take aſſiſes; that is, to take the verdict of a peculiar ſpecies of jury called *an aſſiſe*, and ſummoned for the trial of *landed* diſputes. The other authority is, 5. That of *niſi prius*, which is a conſequence of the commiſſion of *aſſiſe*, being annexed to the office of thoſe juſtices by the ſtatute of Weſtm. 2. 13 Edw. I. c. 30. And it empowers them to try all queſtions of fact iſſuing out of the courts of Weſtminſter, that are then ripe for trial by jury. The original of the name is this: all cauſes commenced in the courts of Weſtminiſter-hall are by the courſe of the courts appointed to be there tried, on a day fixed in ſome Eaſter or Michaelmas term, by a jury returned from the county wherein the cauſe of action ariſes; but with this proviſo, *niſi prius juſticiarii ad aſſiſas capiendas venerint; unleſs before* the day prefixed the judges of aſſiſe come into the county in queſtion. This they are ſure to do in the vacations preceding each Eaſter and Michaelmas term, and there diſpoſe of the cauſe; which ſaves much expence and trouble, both to the parties, the jury, and the witneſſes.

The word *aſſiſe* (from the French *aſſis*, ſeated, ſettled, or eſtabliſhed, and formed of the Latin verb *aſſideo*, I ſit by) is uſed in ſeveral different ſenſes. It is ſometimes taken for the ſittings of a court; ſometimes for its regulations or ordinances, eſpecially thoſe that fix

the

Aſſiſio / Aſſociation

the ſtandard of weights and meaſures; and ſometimes it ſignifies a jury, either becauſe juries conſiſted of a fixed determined number, or becauſe they continued ſitting till they pronounced their verdict. In Scots law, an aſſiſe or jury conſiſts of fifteen ſworn men (*juratores*), picked out by the court from a greater number, not exceeding 45, who have been ſummoned for that purpoſe by the ſheriff, and given in liſt to the defender, at ſerving him with a copy of his libel.

ASSISIO, an epiſcopal town of Italy, in the duchy of Spoleto, built on the ſide of a very high mountain. The cathedral of St Francis is very magnificent, and compoſed of three churches one above another. E. Long. 13. 35. N. Lat. 43. 4.

ASSITHMENT, a wiregeld, or compenſation, by a pecuniary mulct; from the prepoſition *ad*, and the Sax. *ſithe, vicè: quod vicè ſupplicii ad expiandum delictum ſolvitur.*

ASSOCIATION, the act of aſſociating, or conſtituting a ſociety, or partnerſhip, in order to carry on ſome ſcheme or affair with more advantage.—The word is Latin, *aſſociatio*; and compounded of *ad*, to, and *ſocio*, to join.

Association of Ideas, is where two or more ideas conſtantly and immediately follow or ſucceed one another in the mind, ſo that one ſhall almoſt infallibly produce the other whether there be any natural relation between them or not. See METAPHYSICS.

Where there is a real affinity or connection in ideas, it is the excellency of the mind to be able to collect, compare, and range them in order, in its inquiries: but where there is none, nor any cauſe to be aſſigned for their accompanying each other, but what is owing to mere accident or habit; this unnatural aſſociation becomes a great imperfection, and is, generally ſpeaking, a main cauſe of error, or wrong deductions in reaſoning. Thus the idea of goblins and ſprights, it has been obſerved, has really no more affinity with darkneſs than with light; and yet let a fooliſh maid inculcate theſe ideas often on the mind of a child, and raiſe them there together, it is poſſible he ſhall never be able to ſeparate them again ſo long as he lives, but darkneſs ſhall ever bring with it thoſe frightful ideas. With regard to this inſtance, however, it muſt at the ſame time be obſerved, that the connection alluded to appears far from being either unnatural or abſurd. See the article APPARITION.

Such wrong combinations of ideas, Mr Locke ſhows, are a great cauſe of the irreconcileable oppoſition between the different ſects of philoſophy and religion: for we cannot imagine, that all who hold tenets different from, and ſometimes even contradictory to, one another, ſhould wilfully and knowingly impoſe upon themſelves, and refuſe truth offered by plain reaſon: but ſome looſe and independent ideas are by education, cuſtom, and the conſtant din of their party, ſo coupled in their minds that they always appear there together: theſe they can no more ſeparate in their thoughts, than if they were but one idea, and they operate as if they were ſo. This gives ſenſe to jargon, demonſtration to abſurdities, conſiſtency to nonſenſe, and is the foundation of the greateſt, and almoſt of all, the errors in the world.

Aſſociation forms a principal part of Dr Hartley's mechanical theory of the mind. He diſtinguiſhes it into ſynchronous and ſucceſſive; and aſcribes our ſimple and complex ideas to the influence of this principle or habit. Particular ſenſations reſult from previous vibrations conveyed through the nerves to the medullary ſubſtance of the brain; and theſe are ſo intimately aſſociated together, that any one of them, when impreſſed alone, ſhall be able to excite in the mind the ideas of all the reſt. Thus we derive the ideas of natural bodies from the aſſociation of the ſeveral ſenſible qualities with the names that expreſs them, and with each other. The ſight of part of a large building ſuggeſts the idea of the reſt inſtantaneouſly, by a ſynchronous aſſociation of the parts; and the ſound of the words, which begin a familiar ſentence, brings to remembrance the remaining parts, in order, by ſucceſſive aſſociation. Dr Hartley maintains, that ſimple ideas run into complex ones by aſſociation; and apprehends, that by purſuing and perfecting this doctrine, we may ſome time or other be enabled to analyſe thoſe complex ideas that are commonly called the *ideas of reflection*, or *intellectual ideas*, into their ſeveral component parts, i. e. into the ſimple idea of ſenſation of which they conſiſt; and that this doctrine may be of conſiderable uſe in the art of logic, and in explaining the various phenomena of the human mind. Aſſociation / Aſſumpſit.

Association of Parliament. In the reign of king William III. the Britiſh parliament entered into a ſolemn aſſociation to defend his majeſty's perſon and government againſt all plots and conſpiracies; and all perſons bearing offices civil or military, were enjoined to ſubſcribe the aſſociation to ſtand by king William, on pain of forfeitures and penalties, &c. by ſtat. 7 and 8 W. III. c. 27.

ASSOILZIE, in law, to abſolve or free.

ASSONANCE, in rhetoric and poetry, a term uſed where the words of a phraſe or a verſe have the ſame ſound or termination, and yet make no proper rhyme. Theſe are uſually accounted vicious in Engliſh; though the Romans ſometimes uſed them with elegancy: as, *Militem comparavit, exercitum ordinavit, aciem luſtravit.*

ASSONANT RHYMES, is a term particularly applied to a kind of verſes among the Spaniards, where a reſemblance of ſound ſerves inſtead of a natural rhyme. Thus, *ligera, cubierta, tierra, meſa*, may anſwer each other in a kind of *aſſonant* rhyme, having each an *e* in the penult ſyllable, and *a* in the laſt.

ASSUAN. See SYENE.

ASSUMPSIT, in the law of England, a voluntary or verbal promiſe, whereby a perſon aſſumes, or takes upon him to perform or pay any thing to another.

A promiſe is in the nature of a verbal covenant, and wants nothing but the ſolemnity of writing and ſealing to make it abſolutely the ſame. If therefore it be to do any explicit act, it is an expreſs contract, as much as any covenant: and the breach of it is an equal injury. The remedy indeed is not exactly the ſame: ſince, inſtead of an action of covenant, there only lies an action upon the caſe, for what is called an *aſſumpſit* or undertaking of the defendant; the failure of performing which is the wrong or injury done to the plaintiff, the damages whereof a jury are to eſtimate and ſettle. As, if a builder promiſes, undertakes, or aſſumes to Caius, that he will build and cover his houſe within a time limited, and fails to do it; Caius has an action on the caſe againſt the builder for this breach

Aſſumpſit. breach of his expreſs promiſe, undertaking, or aſſumpſit; and ſhall recover a pecuniary ſatisfaction for the injury ſuſtained by ſuch delay. So alſo in the caſe of a debt by ſimple contract, if the debtor promiſes to pay and does not, this breach of promiſe intitles the creditor to his action on the caſe, inſtead of being driven to an action of debt. Thus likewiſe a promiſſory note, or note of hand not under ſeal to pay money at a day certain, is an expreſs aſſumpſit; and the payee at common law, or by cuſtom and act of parliament the indorſee, may recover the value of the note in damages, if it remains unpaid. Some agreements indeed, though never ſo expreſsly made, are deemed of ſo important a nature, that they ought not to reſt in verbal promiſe only which cannot be proved but by the memory (which ſometimes will induce the perjury) of witneſſes. To prevent which, the ſtatute of frauds and perjuries, 29 Car. II. c. 3. enacts, that in the five following caſes no verbal promiſe ſhall be ſufficient to ground an action upon, but at the leaſt ſome note or memorandum of it ſhall be made in writing, and ſigned by the party to be charged therewith: 1. When an executor or adminiſtrator promiſes to anſwer damages out of his own eſtate. 2. Where a man undertakes to anſwer for the debt, default, or miſcarriage, of another. 3. Where any agreement is made upon conſideration of marriage. 4. Where any contract or ſale is made of lands, tenements, or hereditaments, or any intereſt therein. 5. And laſtly, where there is any agreement that is not to be performed within a year from the making thereof. In all theſe caſes, a mere verbal aſſumpſit is void.

From theſe expreſs contracts the tranſition is eaſy to thoſe that are only implied by law. Which are ſuch as reaſon and juſtice dictate, and which therefore the law preſumes that every man has contracted to perform; and, upon this preſumption, makes him anſwerable to ſuch perſons as ſuffer by his non-performance.

Thus, 1. If I employ a perſon to tranſact any buſineſs for me, or perform any work, the law implies that I undertook, or aſſumed, to pay him ſo much as his labour deſerved: and if I neglect to make him amends, he has a remedy for this injury by bringing his action on the caſe upon this implied aſſumpſit; wherein he is at liberty to ſuggeſt that I promiſed to pay him ſo much as he reaſonably deſerved, and then to aver that his trouble was really worth ſuch a particular ſum, which the defendant has omitted to pay. But this valuation of his trouble is ſubmitted to the determination of a jury; who will aſſeſs ſuch a ſum in damages as they think he really merited. This is called an *aſſumpſit* on a *quantum meruit*.

2. There is alſo an implied aſſumpſit on a *quantum valebat*, which is very ſimilar to the former; being only where one takes up goods or wares of a tradeſman, without expreſsly agreeing for the price. There the law concludes, that both parties did intentionally agree that the real value of the goods ſhould be paid; and an action on the caſe may be brought accordingly, if the vendee refuſes to pay that value.

3. A third ſpecies of implied aſſumpſit is when one has had and received money belonging to another without any valuable conſideration given on the receiver's part; for the law conſtrues this to be money had and received for the uſe of the owner only; and implies that the perſon ſo receiving, promiſed and undertook to account for it to the true proprietor. And, if he unjuſtly detains it, an action on the caſe lies againſt him for the breach of ſuch implied promiſe and undertaking; and he will be made to repair the owner in damages, equivalent to what he has detained in ſuch violation of his promiſe. This is a very extenſive and beneficial remedy, applicable to almoſt every caſe where the defendant has received money which *ex æquo et bono* he ought to refund. It lies for money paid by miſtake, or on a conſideration which happens to fail, or through impoſition, extortion, or oppreſſion, or where undue advantage is taken of the plaintiff's ſituation. Aſſumpſit.

4. Where a perſon has laid out and expended his own money for the uſe of another at his requeſt, the law implies a promiſe of repayment, and an action will lie on this aſſumpſit.

5. Likewiſe, fifthly, upon a ſtated account between two merchants, or other perſons, the law implies that he againſt whom the balance appears has engaged to pay it to the other; though there be not any actual promiſe. And from this implication it is frequent for actions on the caſe to be brought, declaring that the plaintiff and defendant had ſettled their accounts together, *inſimul computaſſent*, (which gives name to this ſpecies of aſſumpſit); and that the defendant engaged to pay the plaintiff the balance, but has ſince neglected to do it. But if no account has been made up, then the legal remedy is by bringing a writ of *account de computo*; commanding the defendant to render a juſt account to the plaintiff, or ſhew the court good cauſe to the contrary. In this action, if the plaintiff ſucceeds, there are two judgments; the firſt is, that the defendant do account *(quod computet)* before auditors appointed by the court; and when ſuch account is finiſhed, then the ſecond judgment is, that he do pay the plaintiff ſo much as he is found in arrear.

6. The laſt claſs of contracts, implied by reaſon and conſtruction of law, ariſes upon this ſuppoſition, that every one who undertakes any office, employment, truſt, or duty, contracts with thoſe who employ or entruſt him, to perform it with integrity, diligence, and ſkill: and if by his want of either of thoſe qualities any injury accrues to individuals, they have therefore their remedy in damages, by a ſpecial action on the caſe. A few inſtances will fully illuſtrate this matter. If an officer of the public is guilty of neglect of duty, or a palpable breach of it, of non-feaſance or of miſ-feaſance; as, if the ſheriff does not execute a writ ſent to him, or if he wilfully makes a falſe return thereof; in both theſe caſes, the party aggrieved ſhall have an action *on the caſe*, for damages to be aſſeſſed by a jury. If a ſheriff or goaler ſuffers a priſoner who is taken upon meſne proceſs (that is, during the pendency of a ſuit) to eſcape, he is liable to an action *on the caſe*. But if after judgment, a goaler or a ſheriff permits a debtor to eſcape, who is charged in execution for a certain ſum; the debt immediately becomes his own, and he is compellable by action of *debt*, being for a ſum liquidated and aſcertained, to ſatisfy the creditor in his whole demand. An advocate or attorney that betray the cauſe of their client, or, being retained, neglect to appear at the trial, by which the cauſe miſcarries, are liable to an action on the caſe, for a reparation to their injured client. There is alſo in law always an implied

Assumption | Assus.

implied contract with a common innkeeper, to ſecure his gueſt's goods in his inn; with a common carrier or barge-maſter, to be anſwerable for the goods he carries; with a common farrier, that he ſhoes a horſe well, without laming him; with a common taylor, or other workman, that he performs his buſineſs in a workmanlike manner; in which if they fail, an action on the caſe lies to recover damages for ſuch breach of their general undertaking. Alſo if an innkeeper, or other victualler, hangs out a ſign and opens his houſe for travellers, it is an implied engagement to entertain all perſons who travel that way; and upon this univerſal *aſſumpſit* an action on the caſe will lie againſt him for damages, if he without good reaſon refuſes to admit a traveller. In contracts likewiſe for ſales, if the ſeller doth upon the ſale warrant it to be good, the law annexes a tacit contract to this warranty, that if it be not ſo, he ſhall make compenſation to the buyer: elſe it is an injury to good faith, for which an action on the caſe will lie to recover damages.

ASSUMPTION, a feſtival in the Romiſh church, in honour of the miraculous aſcent of the Virgin Mary into heaven: the Greek church, who alſo obſerve this feſtival, celebrate it on the 15th of Auguſt with great ceremony.

ASSUMPTION, in logic, is the minor or ſecond propoſition in a categorical ſyllogiſm.

ASSUMPTION is alſo uſed for a conſequence drawn from the propoſitions whereof an argument is compoſed.

ASSUMPTION, an iſland of North-America, in the gulph of St Lawrence, at the mouth of the great river of the ſame name. It is covered with trees. W. Long. 60. 40. N. Lat. 49. 30.

ASSUMPTION, a large and handſome town of Proper Paraguay, on the river of the ſame name in South America. It is a biſhop's ſee, is well peopled, and ſeated in a country fruitful in corn and fruits, whoſe trees are always green. There is likewiſe a quantity of paſture, and the air is temperate and ſalutary. W. Long. 60. 40. S. Lat. 34. 10.

ASSUMPTIVE ARMS, in heraldry, are ſuch as a perſon has a right to aſſume, with the approbation of his ſovereign, and of the heralds: thus, if a perſon, who has no right by blood, and has no coat of arms, ſhall captivate, in any lawful war, any gentleman, nobleman, or prince, he is, in that caſe, entitled to bear the ſhield of that priſoner, and enjoy it to him and his heirs for ever.

ASSURANCE, or INSURANCE, in commerce. See INSURANCE.

ASSUROR, a merchant, or other perſon, who makes out a policy of aſſurance, and thereby inſures a ſhip, houſe, or the like.

ASSUS, or Assos (anc. geog.), a town of Troas (though by others ſuppoſed to be of Myſia), and the ſame with Apollonia (Pliny); but different from the Apollonia on the river Rhyndacus. Ptolemy places it on the ſea-coaſt, but Strabo more inland; if he does not mean the head of an inland bay, as appears from Diodorus Siculus. It was the country of Cleanthes the ſtoic philoſopher, who ſucceeded Zeno. St Luke and others of St Paul's companions in his voyage (Acts xx. 13. 14), went by ſea from Troas to Aſſos; but St Paul went by land thither, and meeting them at Aſſos, they all went together to Mytelene. It is ſtill called *Aſſos*. E. Long. 27. 30. Lat. 38. 30. Aſſyria.

ASSYRIA, an ancient kingdom of Aſia, concerning the extent, commencement, and duration of which, hiſtorians differ greatly in their accounts. Several ancient writers, in particular Cteſias and Diodorus Siculus, have affirmed, that the Aſſyrian monarchy, under Ninus and Semiramis, comprehended the greater part of the known world. Had this been the caſe, it is not likely that Homer and Herodotus would have omitted a fact ſo remarkable. The ſacred records intimate, that none of the ancient ſtates or kingdoms were of conſiderable extent; for neither Chederlaomer, nor any of the neighbouring princes, were tributary or ſubject to Aſſyria; and we find nothing of the greatneſs or power of this kingdom in the hiſtory of the Judges and ſucceeding kings of Iſrael, though the latter kingdom was oppreſſed and enſlaved by many different powers in that period. It is highly probable, therefore, that Aſſyria was originally of ſmall extent. According to Ptolemy, it was bounded on the north by Armenia Major; on the weſt by the Tigris; on the ſouth by Suſiana; and on the eaſt by Media.

It is probable, that the origin and revolutions of the Aſſyrian monarchy were as follows.—The founder of it was Aſhur, the ſecond ſon of Shem, who went out of Shinar, either by the appointment of Nimrod, or to elude the fury of a tyrant; conducted a large body of adventurers into Aſſyria, and laid the foundation of Nineveh (Gen. x. 11.) Theſe events happened not long after Nimrod had eſtabliſhed the Chaldæan monarchy, and fixed his reſidence at Babylon. The Perſian hiſtorians ſuppoſe that the kings of Perſia of the firſt dynaſty were the ſame with the kings of Aſſyria, of whom Zohah, or Nimrod, was the founder of Babel (Herbelot Orient. Bibl. v. *Bagdad*). It does not, however, appear, that Nimrod reigned in Aſſyria. The kingdoms of Babylon and Aſſyria, were originally diſtinct and ſeparate (Micah v. 6.), and in this ſtate they remained until Ninus conquered Babylon, and made it tributary to the Aſſyrian empire. Ninus, the ſucceſſor of Aſhur (Gen. x. 11. Diod. Sic. L. 1.), ſeized on Chaldæa, after the death of Nimrod, and united the kingdoms of Aſſyria and Babylon. This great prince is ſaid to have ſubdued Aſia, Perſia, Media, Egypt, &c. If he did ſo, the effects of his conqueſts were of no duration; for, in the days of Abraham, we do not find that any of the neighbouring kingdoms were ſubject to Aſſyria. He was ſucceeded by Semiramis; a princeſs of an heroic mind; bold, enterpriſing, fortunate; but of whom many fabulous things have been recorded. It appears, however, that there were two princeſſes of the ſame name, who flouriſhed at very different periods. One of them was the conſort of Ninus; and the other lived five generations before Nitocris queen of Nebuchadnezzar (Euſeb. Chron. p. 58. Herod. L. i. c. 184.) This fact has not been attended to by many writers. *Playfair's Chronology.*

Whether there was an uninterrupted ſeries of kings from Ninus to Sardanapalus, or not, is ſtill a queſtion. Some ſuſpicion has ariſen, that the liſt which Cteſias has given of the Aſſyrian kings is not genuine; for many names in it are of Perſian, Egyptian, and Grecian extraction.

Nothing memorable has been recorded concerning the

Aſſyria | Aſta.

ſucceſſors of Ninus and Semiramis. Of that effeminate race of princes it is barely ſaid, that they aſcended the throne, lived in indolence, and died in their palace at Nineveh. Diodorus (L. ii.) relates, that, in the reign of Teutames, the Aſſyrians, ſolicited by Priam their vaſſal, ſent to the Trojans a ſupply of 20,000 foot and 200 chariots, under the command of Memnon, ſon of Tithonus preſident of Perſia: But the truth of this relation is rendered doubtful by the accounts of other writers.

Sardanapalus was the laſt of the ancient Aſſyrian kings. Contemning his indolent and voluptuous courſe of life, Arbaces, governor of Media, withdrew his allegiance, and roſe up in rebellion againſt him. He was encouraged in this revolt by the advice and aſſiſtance of Beleſis, a Chaldean prieſt, who engaged the Babylonians to follow the example of the Medes. Theſe powerful provinces, aided by the Perſians and other allies, who deſpiſed the effeminacy, or dreaded the tyranny of their Aſſyrian lords, attacked the empire on all ſides. Their moſt vigorous efforts were, in the beginning, unſucceſsful. Firm and determined, however, in their oppoſition, they at length prevailed, defeated the Aſſyrian army, beſieged Sardanapalus in his capital, which they demoliſhed, and became maſters of the empire, B. C. 821.

After the death of Sardanapalus, the Aſſyrian empire was divided into three kingdoms, viz. the Median, Aſſyrian, and Babylonian. Arbaces retained the ſupreme power and authority, and fixed his reſidence at Ecbatana in Media. He nominated governors in Aſſyria and Babylon, who were honoured with the title of *kings*, while they remained ſubject and tributary to the Median monarchs. Beleſis received the government of Babylon as the reward of his ſervices; and Phul was entruſted with that of Aſſyria. The Aſſyrian governor gradually enlarged the boundaries of his kingdom, and was ſucceeded by Tiglath-pileſer, Salmanaſar, and Sennacherib, who aſſerted and maintained their independency. After the death of Aſſar-haddon, the brother and ſucceſſor of Senacherib, the kingdom of Aſſyria was ſplit, and annexed to the kingdoms of Media and Babylon. Several tributary princes afterwards reigned in Nineveh; but no particular account of them is found in the annals of ancient nations. We hear no more of the kings of Aſſyria, but of thoſe of Babylon. Cyaxares king of Media, aſſiſted Nebuchadnezzar king of Babylon, in the ſiege of Nineveh, which they took and deſtroyed, B. C. 606. The Chaldean or Babyloniſh kingdom was transferred to the Medes, after the reign of Nabonadius, ſon of Evilmerodach, and grandſon of Nebuchadnezzar. He is ſtyled Belſhazzar in the ſacred records, and was conquered by Cyrus, B. C. 538.

ASSYTHMENT. See ASSITHMENT.

ASTA, an inland town of Liguria, a colony, (Ptolemy); on the river Tanarus: Now *Aſti*. E. Long. 8. 15. Lat. 44. 40.

ASTA Regia, a town of Bætica, (Pliny); ſituated at that mouth of the Bætis which was choaked up with mud, to the north of Cadiz; 16 miles diſtant from the port of Cadiz, (Antonine). Its ruins ſhow its former greatneſs. Its name is Phœnician, denoting a *frith* or arm of the ſea, on which it ſtood. It is ſaid to be the ſame with XERA; which ſee.

Aſtabat | Aſtell.

ASTABAT, a town of Armenia, in Aſia, ſituated near the river Aras, 12 miles ſouth of Nakſhivan. The land about it is excellent, and produces very good wine. There is a root peculiar to this country, called *ronas*; which runs in the ground like liquorice, and ſerves for dyeing red. It is very much uſed all over the Indies, and for it they have a great trade. E. Long. 46. 30. N. Lat. 39. 0.

ASTANDA, in antiquity, a royal courier or meſſenger, the ſame with ANGARUS.—King Darius of Perſia is ſaid by Plutarch, in his book on the fortune of Alexander, to have formerly been an *aſtanda*.

ASTAROTH, or ASHTAROTH, in antiquity, a goddeſs of the Sidonians.—The word is Syriac, and ſignifies *ſheep*, eſpecially when their udders are turgid with milk. From the fecundity of theſe animals, which in Syria continue to breed a long time, they formed the notion of a deity, whom they called *Aſtaroth*, or *Aſtarte*. See ASTARTE.

ASTAROTH, (anc. geog.) the royal reſidence of Og king of Baſhan; whether the ſame with Aſtaroth Carnaim, is matter of doubt: if one and the ſame, it follows from Euſebius's account, that it lay in Baſhan, and to the eaſt of Jordan, becauſe in the confines of Arabia.

ASTARTE, in Pagan mythology (the ſingular of Aſtaroth), a Phœnician goddeſs, called in Scripture the *queen of heaven*, and the *goddeſs of the Sidonians*.—Solomon, in complement to one of his queens, erected an alter to her. In the reign of Ahab, Jezebel cauſed her worſhip to be performed with much pomp and ceremony: ſhe had 400 prieſts; the women were employed in weaving hangings or tabernacles for her; and Jeremiah obſerves, that "the children gathered the "wood, the fathers kindled the fire, and the women "kneaded the dough, to make cakes for the queen of "heaven."

ASTARTE, (anc. geog.) a city on the other ſide Jordan; one of the names of Rabbath Ammon, in Arabia Petræa, (Stephanus).

ASTEISM, in rhetoric, a genteel irony, or handſome way of deriding another. Such, *e. gr.* is that of Virgil:

Qui Bavium non odit, amet tua carmina, Mævi, &c.

Diomed places the characteriſtic of this figure, or ſpecies of irony, in that it is not groſs and ruſtic, but ingenious and polite.

ASTELL (Mary), the great ornament of her ſex and country, was the daughter of —— Aſtell, an opulent merchant of Newcaſtle upon Tyne, where ſhe was born about the year 1668. She was educated in a manner ſuitable to her ſtation; and, amongſt other accompliſhments, was miſtreſs of the French, and had ſome knowledge of the Latin tongue. Her uncle, a clergyman, obſerving in her ſome marks of a promiſing genius, took her under his tuition, and taught her mathematics, logic, and philoſophy. She left the place of her nativity when ſhe was but 20 years of age, and ſpent the remaining part of her life at London and at Chelſea. Here ſhe purſued her ſtudies with great aſſiduity, made great proficiency in the abovementioned ſciences, and acquired a more complete knowledge of many claſſic authors. Among theſe Seneca, Epictetus, Hierocles, Antoninus, Tully, Plato, and Xenophon, were her principal favorites.

Aſtell
|
Aſterabad.

Her life was ſpent in writing for the advancement of learning, religion, and virtue; and in the practice of thoſe religious duties which ſhe ſo zealouſly and pathetically recommended to others, and in which perhaps no one was ever more ſincere and devout. Her ſentiments of piety, charity, humility, and other Chriſtian graces, were uncommonly refined and ſublime; and religion ſat gracefully upon her, unattended with any forbidding airs of ſourneſs or of gloom. Her mind was generally calm and ſerene; and her converſation was innocently facetious, and highly entertaining. She would ſay, "The good Chriſtian only hath reaſon, and he always ought, to be cheerful;" and, "That dejected looks and melancholy airs were very unſeemly in a Chriſtian." But theſe ſubjects ſhe hath treated at large in ſome of her excellent writings.

She was remarkably abſtemious; and ſeemed to enjoy an uninterrupted ſtate of health till a few years before her death; when, having one of her breaſts cut off, it ſo much impaired her conſtitution, that ſhe did not long ſurvive it. This painful operation ſhe underwent without diſcovering the leaſt timidity, or ſo much as uttering a groan; and ſhowed the ſame reſolution and reſignation during her whole illneſs. When ſhe was confined to her bed by a gradual decay, and the time of her diſſolution drew near, ſhe ordered her ſhroud and coffin to be made and brought to her bedſide; and there to remain in her view, as a conſtant memento of her approaching fate, and to keep her mind fixed on proper contemplation. She died in the year 1731, in the 63d year of her age, and was buried at Chelſea. She wrote, 1. A Serious Propoſal to the Ladies. 2. An Eſſay in Defence of the Female Sex. 3. Letters concerning the Love of God. 4. Reflections upon Marriage. 5. Moderation truly ſtated. 6. The Chriſtian Religion, as profeſſed by a Daughter of the Church of England; and ſome other works.

ASTER, STARWORT: A genus of the polygamia ſuperflua order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ diſcoides*. The receptacle is naked; the papus is ſimple; the rays of the corolla are 10; and the calyx is imbricated. There are above 30 ſpecies. All of them may be raiſed from ſeed ſown either in autumn or ſpring: but the greateſt part of them being perennial plants, and increaſing greatly at the roots, are generally propagated by parting their roots early in the ſpring, and they will grow in almoſt any ſoil or ſituation; and the larger ſorts increaſe ſo faſt, that, if not prevented, they will in a little time run over a large ſpace of ground. They grow beſt in the ſhade: the lower kinds do not run ſo much at the root, but ſhould be taken up and tranſplanted every other year; which will make them produce much fairer flowers. Some few ſorts, which are natives of warm climates, will require artificial heat to raiſe them, if not to preſerve them.

ASTER, or *Stella Marina*, in zoology. See ASTERIAS.

ASTERABAD, a province in the north-eaſt part of Perſia, having Tabriſtan on the weſt, part of the Caſpian Sea and part of Jorjan on the north, Koraſan on the weſt, and Koumas on the ſouth. It is a mountainous country, except near the banks of the rivers that almoſt ſurround it, where it is pleaſant, and fruitful, producing grapes of a prodigious ſize. In other parts the ſoil is ſandy and barren. Aſterabad is the chief town, which gives name to a gulph in the Perſian Sea, at the bottom of which it ſtands. E. Long. 54. 35. N. Lat. 36. 50.

Aſteria
Aſterias.

ASTERIA, in zoology, a name by which ſome authors have called the *falco palumbarius*, or *goſhawk*. See FALCO.

ASTERIA is alſo the name of a gem, uſually called the *cat's eye*, or *oculus cati*. It is a very ſingular and very beautiful ſtone, and ſomewhat approaches to the nature of the opal, in having a bright included colour, which ſeems to be lodged deep in the body of the ſtone, and ſhifts about, as it is moved, in various directions: but it differs from the opal in all other particulars, eſpecially in its want of the great variety of colours ſeen in that gem, and in its ſuperior hardneſs. It is uſually found between the ſize of a pea and the breadth of a ſixpence; is almoſt always of a ſemicircular form, broad and flat at the bottom, and rounded and convex at the top; and is naturally ſmooth and poliſhed. It has only two colours, a pale brown and a white; the brown ſeeming the ground, and the white playing about in it, as the fire colour in the opal. It is conſiderably hard, and will take a fine poliſh, but is uſually worn with its native ſhape and ſmoothneſs. It is found in the Eaſt and Weſt Indies, and in Europe. The iſland of Borneo affords ſome very fine ones, but they are uſually ſmall; they are very common in the ſands of rivers in New Spain; and in Bohemia they are not unfrequently found immerſed in the ſame maſſes of jaſper with the opal.

ASTERIA is alſo the name of an extraneous foſſil, called in Engliſh the *ſtar-ſtone*. Theſe foſſils are ſmall, ſhort, angular, or ſulcated columns, between one and two inches long, and ſeldom above a third of an inch in diameter: compoſed of ſeveral regular joints; when ſeparated, each reſembles a radiated ſtar. They are, not without reaſon, ſuppoſed to be a part of ſome ſea-fiſh petrified, probably the aſterias or ſea-ſtar. The aſteria is alſo called *aſtrites*, *aſtroites*, and *aſteriſcus*. They may be reduced to two kinds: thoſe whoſe whole bodies make the form of a ſtar; and thoſe which in the whole are irregular, but are adorned as it were with conſtellations in the parts. Dr Liſter, for diſtinction's ſake, only gives the name *aſteria* to the former ſort, diſtinguiſhing the latter by the appellation of *aſtroites*; other naturaliſts generally uſe the two indiſcriminately. The aſteria ſpoken of by the ancients appears to be of this latter kind. The quality of moving in vinegar, as if animated, is ſcarce perceivable in the aſtroites, but is ſignal in the aſteria. The former muſt be broken in ſmall pieces before it will move; but the latter will move, not only in a whole joint, but in two or three knit together. The curious frequently meet with theſe ſtones in many parts of England: at Cleydan in Oxfordſhire they are found rather larger than common, but of a ſofter ſubſtance; for, on being left a ſmall ſpace of time in a ſtrong acid, they may eaſily be ſeparated at the joints in ſmall plates.

ASTERIAS, STAR-FISH, or SEA-STAR, in zoology, a genus of inſects of the order of vermes molluſca. It has a depreſſed body, covered with a coriaceous coat; is compoſed of five or more ſegments, running out from

Aſterias. a central part, and furniſhed with numerous tentacula; and has the mouth in the centre.—The conformation of the mouth is this: The under part of each lobe runs towards a point with the reſt at the centre of the body; and theſe ſeveral productions of the rays make a ſort of lips, the ends of each of which are armed with a number of ſharp teeth, which ſerve to take and convey the food into the body. From this mouth there goes a ſeparate canal to all or many of the rays, which runs through their whole length, and becomes gradually narrower as it approaches the extremity. The tentacula reſembles the horns of ſnails, but ſerve the animal to walk with. They are capable of being contracted or ſhortened: and it is only at the creature's moving that they are ſeen of their full length; at other times, no part of them is ſeen but the extremity of each, which is formed like a ſort of button, being ſomewhat larger than the reſt of the horn.

Moſt of the ſpecies of aſterias are found in the Britiſh ſeas. 1. The glacialis, with five rays, depreſſed, broad at the baſe, yellow, and having a round ſtriated operculum on the back, is the moſt common; it feeds on oyſters, and is very deſtructive to the beds. 2. The clathatra, or cancellated ſea-ſtar, with five ſhort thick rays, hirſute beneath, cancellated above, is found with the former, but more rare. 3. The oculata, with five ſmooth rays, dotted or punctured, is of a fine purple colour, and is found about Angleſea. 4. The hiſpida, with five rays, broad, angulated at top, and rough with ſhort briſtles, is of a brown colour, and likewiſe found about Angleſea. 5. The placenta, with five very broad and membranaceous rays, extremely thin and flat, is found about Weymouth. 6. The ſpherulata, with a pentagonal indented body; a ſmall globular bead between the baſe of each ray; the rays ſlender, jointed, taper, and hirſute on their ſides; found off Angleſea. 7. The caput meduſæ, or aboreſcent ſea-ſtar, with five rays iſſuing from an angular body; the rays dividing into innumerable branches, growing ſlender as they recede from the baſe. Theſe the animal, in ſwimming, ſpreads like a net to their full length; and when he perceives any prey within them, draws them in again, thus catching it with all the dexterity of a fiſherman. It is an inhabitant of every ſea, and is called by ſome the *Magellanic ſtar-fiſh* and *baſket-fiſh*. When it extends its rays fully, it forms a circle of three feet diameter. The fragments of theſe rays furniſh the foſſile entrochi. If we drown this animal in brandy or ſpirits of wine, and keep the rays flat and expanded in the execution, it is eaſy to extract, by means of a pair of forceps, the ſtomach of the animal whole and entire through the mouth. The decacnemos, has ten ſlender rays, with numbers of long beards on the ſides: the body is ſmall, and ſurrounded beneath with ten ſmall filiform rays. It inhabits the weſtern coaſts of Scotland.—There are ſeveral other ſpecies mentioned by authors; ſome of them of 10, 12, 13, or even 14 rays.

Ariſtotle and Pliny called this genus ἀστὴρ, and *ſtella marina*, from their reſemblance to the pictured form of the ſtars of heaven; and they aſſerted that they were ſo exceedingly hot, as inſtantly to conſume whatſoever they touched.

The foſſil world has been greatly enriched by the fragments and remains of the ſeveral pieces of ſtar-fiſh which have been converted into ſtones. See ASTERIA. Aſterias

ASTERIAS, the ancient name of the bittern. See ARDEA. Aſtracan.

ASTERISK, a mark in form of a ſtar (*), placed over a word or ſentence, to refer the reader to the margin, or elſewhere, for a quotation, explanation, or the like.

ASTERIUS, or ASTURIUS, a Roman conſul, in 449. We have under his name, *A Conference on the Old and New Teſtament*, in Latin verſe: in which each ſtrophe contains, in the firſt verſe, an hiſtorical fact in the Old Teſtament; and in the ſecond, an application of that fact to ſome point in the New.

ASTERN, a ſea-phraſe, uſed to ſignify any thing at ſome diſtance behind the ſhip, being the oppoſite of AHEAD, which ſignifies the ſpace before her. See AHEAD.

ASTEROPODIUM, a kind of extraneous foſſil, of the ſame ſubſtance with the aſteriæ or ſtar-ſtones, to which they ſerve as a baſe. See ASTERIA and STAR-STONE.

ASTHMA, See the *Index* ſubjoined to MEDICINE.

ASTI, a city of Montferrat in Italy, ſeated on the Tanaro, and capital of the county of the ſame name. It is a biſhop's ſee, and well fortified with ſtrong walls and deep ditches; and is divided into the city, borough, citadel, and caſtle. There are a great many churches and convents, as well as other handſome buildings; and its territory is well watered, abounding with groves, pleaſant hills, and ſpacious fields. It was taken by the French in 1745, and retaken by the king of Sardinia in 1746. E. Long. 8. 15. N. Lat. 54. 50.

ASTIGI, (anc. geog.), a colony, and conventus juridicus, of Bætica, ſurnamed *Auguſta Firma*, ſituated on the Singulus, which falls into the Bætis; called alſo *Colonia Aſtigitana* (Pliny): Now *Ecya*, midway between Seville and Corduba. W. Long. 5°. Lat. 37. 20.

ASTOMI, in anthropology, a people feigned without mouths. Pliny ſpeaks of a nation of Aſtomi in India, who lived only by the ſmell or effluvia of bodies taken in by the noſe.

ASTORGA, a very ancient city of Spain, in the kingdom of Leon, with a biſhop's ſee, is ſeated on the river Tuerta, and well fortified both by art and nature. It ſtands in a moſt agreeable plain, about 150 miles north-weſt of Madrid. There are excellent trouts in the river. W. Long. 6. 20. N. Lat. 42. 20.

ASTRACAN, a province of Ruſſia, and the moſt eaſterly part of Europe; bounded on the north by Bulgaria, and Baſkiria; on the ſouth, by the Caſpian Sea; on the weſt, by the Volga, which divides it from the Nagayan Tartars and Don Coſſacks; and on the eaſt, by the great ridge of mountains which part it from Great Tartary. The province extends from the 46th to the 52d degree of latitude. The ſummer is long, and intenſely hot: the winter continues about three months ſo ſevere, that the Volga is frozen hard enough to bear loaded ſledges. The ſoil is rich and fertile; but the Tartars who inhabit it are ſtrangers to agriculture. On the weſtern and ſouthern ſides of the Volga are heaths of a prodigious extent, ſandy, deſert, and uncultivated: theſe, however, produce vaſt quantities of fine tranſparent ſalt in pits, where the ſun bakes and incruſtates it to the thickneſs of an inch on the ſurface of

Aſtracan. the water. There are pits in the neighbourhood of Aſtracan which yield this excellent ſalt in ſuch abundance, that any perſon may carry it off, paying at the rate of one farthing a pooſt, which is equal to forty pounds. The metropolis Aſtracan, is ſituated within the boundaries of Aſia, on the iſland called *Dolgoi*, about 60 Engliſh miles above the place where the Volga diſembogues itſelf into the Caſpian Sea. The city derives its name from Hadgee Tarken, a Tartar, by whom it was founded. It was conquered by Iwan Baſilowitz, recovered by the Tartars in the year 1668, and retaken by the Czar, who employed for this purpoſe a great number of flat-bottomed veſſels, in which he tranſported his forces down the Volga from Caſan.

The city of Aſtracan is about two miles and a half in circumference, ſurrounded by a brick-wall, which is now in a ruinous condition: but if we comprehend the ſuburbs, the circuit will be near five miles. The number of inhabitants amounts to 70,000, including Armenians and Tartars, as well as a few Perſians and Indians. The garriſon conſiſts of ſix regiments of the beſt Ruſſian troops, who, when this place was alarmed from the ſide of Perſia, had in the adjacent plain erected a great number of ſmall batteries to ſcour the fields, and obſtruct the approach of the enemy. The houſes of Aſtracan are built of wood, and generally mean and inconvenient. The higher parts of the city command a proſpect of the Volga, which is here about three miles in breadth, and exhibits a noble appearance. The marſhy lands on the banks of it render the place very ſickly in the ſummer: the earth being impregnated with ſalt is extremely fertile, and produces abundance of fruit, the immoderate uſe of which is attended with epidemical diſtempers. Sickneſs is likewiſe the conſequence of thoſe annual changes in the atmoſphere produced by the floods in ſpring and autumn. All round the city of Aſtracan, at the diſtance of two miles, are ſeen a vaſt number of gardens, orchards, and vineyards, producing all ſorts of herbs and roots. The grapes are counted ſo delicious, that they are preſerved in ſand, and tranſported to court by land-carriage at a prodigious expence: yet the wine of Aſtracan is very indifferent. The ſummer being generally dry, the inhabitants water their gardens by means of large wheels worked by wind or horſes, which raiſe the water to the higheſt part of the garden, from whence it runs in trenches to refreſh the roots of every ſingle tree and plant. The neighbouring country produces hares and partridges, plenty of quails in ſummmer, with wild and water fowl of all ſorts in abundance.

About ten miles below Aſtracan is a ſmall iſland called *Boſmaiſe*, on which are built large ſtorehouſes for the ſalt, which is made about twelve miles to the eaſtward, and, being brought hither in boats, is conveyed up the Volga, in order to ſupply the country as far as Moſcow and Twere. The quantity of ſalt annually dug for theſe purpoſes amounts to ſome millions of pounds, the excluſive property of which is claimed by the crown, and yields a conſiderable revenue; for the ſoldiers and bulk of the people live almoſt entirely on bread and ſalt. The neighbourhood of theſe ſalt-works is of great advantage to the fiſheries, which extend from hence to the Caſpian Sea, and reach to the ſouth-eaſt as far as Yack, and even 100 miles above Zaritzen. The principal fiſh here caught are ſturgeon and belluga. Theſe being ſalted, are put on board of veſſels, and ſent away in the ſpring, for the uſe of the whole empire, even as far as Peterſburgh: but as fiſh may be kept freſh as long as it is frozen, the winter is no ſooner ſet in than they tranſport great quantities of it by land through all the provinces of Ruſſia. Of the roes of the fiſh called *belluga*, which are white, tranſparent, and of an agreeable flavour, the fiſhers here prepare the caviare, which is in ſo much eſteem all over Europe. Theſe fiſheries were firſt eſtabliſhed by one Tikon Demedoff, a carrier, who ſettled in this place about 60 years ago, his whole wealth conſiſting of two horſes. By dint of ſkill and induſtry, he ſoon grew the richeſt merchant in this country: but his ſucceſs became ſo allurring to the crown, that of late years it hath engroſſed ſome of the fiſheries as well as the ſalt-works. Aſtracan.

From the latter end of July to the beginning of October, the country about Aſtracan is frequently infeſteſt with myriads of locuſts, which darken the air in their progreſſion from the northward to the ſouthward; and, wherever they fall, conſume the whole verdure of the earth. Theſe inſects can even live for ſome time under water; for when the wind blows acroſs the Volga, vaſt numbers of them fall in cluſters and are rolled aſhore; and their wings are no ſooner dry, than they riſe and take flight again.

Heretofore the inhabitants of Aſtracan traded to Khuva and Bokhara; but at preſent theſe branches are loſt, and their commerce is limited to Perſia and the dominions of Ruſſia. Even the trade of Perſia is much diminiſhed by the troubles of that country: nevertheleſs, the commerce of Aſtracan is ſtill conſiderable. Some years ago the city maintained about 40 veſſels, from 100 to 200 tons burden, for the Caſpian traffic. Some of theſe belong to the government, and are commanded by a commodore, under the direction of the admiralty. This office is generally well ſtocked with naval ſtores, which are ſold occaſionally to the merchants. The trading-ſhips convey proviſions to the frontier towns of Terkie and Kiſlar, ſituated on the Caſpian Sea; and tranſport merchandize to ſeveral parts of Perſia. The merchants of Aſtracan export to Perſia, chiefly on account of the Armenians, red leather, linens, woollen cloths, and other European manufactures. In return, they import the commodities of Perſia, particularly thoſe manufactured at Caſan; ſuch as ſilk ſaſhes intermixed with gold, for the uſe of the Poles; wrought ſilks and ſtuffs mixed with cotton; rice, cotton; rhubarb, and a ſmall quantity of other drugs; but the chief commodity is raw ſilk. The government has engroſſed the article of rhubarb, the greater part of which is brought into Ruſſia by the Tartars of Yakutſki, bordering on the eaſtern Tartars belonging to China. They travel through Siberia to Samura, thence to Caſan, and laſtly to Moſcow. The revenue of Aſtracan is computed at 150,000 rubles, or 33,000 pounds, ariſing chiefly from ſalt and fiſh. The city is ruled by a governor, under the check of a chancery. He is nevertheleſs arbitrary enough, and exerciſes oppreſſion with impunity. The officers of the admiralty and cuſtom-houſe having very

Aſtræa | Aſtrantia.

very ſmall ſalaries, are open to corruption, and extremety rapacious. At chriſtening-feaſts which are attended with great intemperance, the gueſts drink a kind of cherry-brandy out of large goblets; and every perſon invited throws a preſent of money into the bed of the mother, who ſits up with great formality to be ſaluted by the company.

The Indians have a Pagan temple at Aſtracan, in which they pay their adoration, and make offerings of fruit to a very ugly deformed idol. The prieſts of this pagod uſe incenſe, beads, cups, and proſtrations. The Tartars, on the contrary, hold idol-worſhip in the utmoſt abomination.

ASTRÆA, in aſtronomy, a name which ſome give to the ſign Virgo, by others called *Erigone*, and ſometimes *Iſis*. The poets feign that juſtice quitted heaven to reſide on earth, in the golden age; but growing weary of the iniquities of mankind, ſhe left the earth, and returned to heaven, where ſhe commenced a conſtellation of ſtars, and from her orb ſtill looks down on the ways of men.

ASTRAGAL, in architecture, a little round moulding, which in the orders ſurround the top of the ſhaft or body of the column. It is alſo called the *talon* and *tondino*; it is uſed at the bottoms as well as tops of columns, and on other occaſions: it properly repreſents a ring, on whatever part of a column it is placed; and the original idea of it was that of a circle of iron put round the trunk of a tree, uſed to ſupport an edifice to prevent its ſplitting. See Plate XXXVI. fig. 2. The aſtragal is often cut into beads and berries, and is uſed in the ornamented entablatures to ſeparate the ſeveral faces of the architrave.

ASTRAGAL, in gunnery, a round moulding encompaſſing a cannon, about half a foot from its mouth.

ASTRAGALOMANCY, a ſpecies of divination performed by throwing ſmall pieces, with marks correſponding to the letters of the alphabet; the accidental diſpoſition of which formed the anſwer required. This kind of divination was practiſed in a temple of Hercules, in Achaia. The word is derived from *αστραγαλος*, and *μαντια*, *divination*.

ASTRAGALLUS, MILK-VETCH, or LIQUORICE-VETCH: A genus of the decandria order, belonging to the diadelphia claſs of plants: and in the natural method ranking under the 32d order, *Papilionaceæ*. The pod is gibbous and billocular. Of this genus there are 39 ſpecies. The common ſort grows wild upon dry uncultivated places, and is recommended by Mr Anderſon to be cultivated as proper food for cattle (See AGRICULTURE, n° 60, 61.). The other ſpecies deſerving notice is the tragagantha, a thorny buſh growing in Crete, Aſia, and Greece, which yields the gum tragracanth. This is of ſo ſtrong a body, that a dram of it, will give a pint of water the conſiſtence of a ſyrup, which a whole ounce of gum Arabic is ſcarce ſufficient to do. Hence its uſe for forming torches, and the like purpoſes, in preference to the other gums.

ASTRAGALUS, in anatomy. See there n° 65.

ASTRANTIA, MASTERWORT: A genus of the digynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 45th order, *Umbellatæ*. The involucrum is lanceolated, open, equal, and coloured. The ſpecies are two, the major and minor, both natives of the Alps, and poſſeſſing no remarkable properties.

Aſtriction | Aſtrology.

ASTRICTION, in law. See THIRLAGE.

ASTRICTION, among phyſicians, denotes the operation of aſtringent medicines.

ASTRINGENTS, in the materia medica, ſubſtances diſtinguiſhed by a rough auſtere taſte, and changing ſolutions of iron, eſpecially thoſe made in the vitriolic acid, into a dark purple or black colour; ſuch are galls, tormentil root, biſtort root, balauſtines, terra Japonica, acacia, &c. See MATERIA MEDICA.

ASTROGNOSIA, the ſcience of the fixed ſtars, or the knowledge of their names, conſtellations, magnitudes, &c. See ASTRONOMY.

ASTROITES, or STAR-STONE, in natural hiſtory. See the articles ASTERIA and STAR-STONE; and Plate LVI.

ASTROLABE, the name of a ſtereographic projection of the ſphere, either upon the plane of the equator, the eye being ſuppoſed to be in the pole of the world; or upon the plane of the meridian, when the eye is ſuppoſed in the point of the interſection of the equinoxial and horizon.

ASTROLABE is alſo the name of an inſtrument formerly uſed for taking the altitude of the ſun or ſtars at ſea.

ASTROLABE, among the ancients, was the ſame as our armillary ſphere.

ASTROLOGY, a conjectural ſcience, which teaches to judge of the effects and influences of the ſtars, and to foretel future events by the ſituation and different aſpects of the heavenly bodies.

This ſcience has been divided into two branches, *natural* and *judiciary*. To the former belongs the predicting of natural effects; as the changes of weather, winds, ſtorms, hurricanes, thunder, floods, earthquakes, &c. This art properly belongs to natural philoſophy; and is only to be deduced *a poſteriori*, from phenomena and obſervations. Judiciary or judicial aſtrology, is that which pretends to foretel moral events, i. e. ſuch as have a dependence on the free will and agency of man; as if they were directed by the ſtars. This art, which owed its origin to the practices of knavery on credulity, is now univerſally exploded by the intelligent part of mankind.

The profeſſors of this kind of aſtrology maintain, "That the heavens are one great volume or book, wherein God has written the hiſtory of the world; and in which every man may read his own fortune, and the tranſactions of his time. The art, ſay they, had its riſe from the ſame hands as aſtronomy itſelf: while the ancient Aſſyrians, whoſe ſerene unclouded ſky favoured their celeſtial obſervations, were intent on tracing the paths and periods of the heavenly bodies, they diſcovered a conſtant ſettled relation of analogy between them and things below; and hence were led to conclude theſe to be the Parcæ, the Deſtinies, ſo much talked of, which preſide at our births, and diſpoſe of our future fate.

"The laws therefore of this relation being aſcertained by a ſeries of obſervations, and the ſhare each planet has therein; by knowing the preciſe time of any perſon's nativity, they were enabled, from their knowledge in aſtronomy, to erect a ſcheme or horoſcope of the ſituation of the planets at that point of time; and hence,

Aſtrology Aſtronomy

hence, by conſidering their degrees of power and influence, and how each was either ſtrengthened or tempered by ſome other, to compute what muſt be the reſult thereof."

Thus the aſtrologers.—But the chief province now remaining to the modern profeſſors, is the making of kalendars or almanacks.

Judicial aſtrology is commonly ſaid to have been invented in Chaldea, and thence tranſmitted to the Egyptians, Greeks, and Romans; though ſome will have it of Egyptian origin, and aſcribe the invention to Cham. But it is to the Arabs that we owe it. At Rome, the people were ſo infatuated with it, that the aſtrologers, or, as they were then called, the *mathematicians*, maintained their ground in ſpite of all the edicts of the emperors to expel them out of the city. See GENETHLIACI.

Add, that the Bramins, who introduced and practiſed this art among the Indians, have hereby made themſelves the arbiters of good and evil hours, which gives them great authority: they are conſulted as oracles; and they have taken care never to ſell their anſwers but at good rates.

The ſame ſuperſtition has prevailed in more modern ages and nations. The French hiſtorians remark, that in the time of queen Catharine de Medicis, aſtrology was in ſo much vogue, that the moſt inconſiderable thing was not to be done without conſulting the ſtars. And in the reigns of king Henry III. and IV. of France, the predictions of aſtrologers were the common theme of the court converſation. This predominant humour in that court was well rallied by Barclay, in his *Argenis*, lib. ii. on occaſion of an aſtrologer, who had undertaken to inſtruct king Henry in the event of a war then threatened by the faction of the Guiſes. Aſtronium | Aſtronomy

ASTRONIUM, in botany: A genus of the pentandria order, belonging to the dicœcia claſs of plants. The male calyx conſiſts of five leaves, and the corolla is quinquepetalous: Of the female the calyx and corolla are the ſame as in the male; the ſtyli are three, and the ſeed is ſingle. There is but one ſpecies, the graveolens, a native of Jamaica.

ASTRONOMICAL, ſomething relating to ASTRONOMY.

ASTRONOMICAL Calendar, an inſtrument engraved on copper plates, printed on paper, and paſted on a board, with a braſs ſlider carrying a hair: it ſhows by inſpection the ſun's meridian altitude, right aſcenſion, declination, riſing, ſetting, amplitude, &c. to a greater degree of exactneſs than the common globes.

ASTRONOMICAL Sector, a very uſeful mathematical inſtrument, made by the late ingenious Mr Graham; a deſcription of which is given in the courſe of the following article.

ASTRONOMY,

IS a knowledge of the heavenly bodies, with regard to their magnitudes, motions, diſtances, &c. whether real or apparent; and of the natural cauſes on which their phenomena depend.

Hiſtory of Aſtronomy.

The antiquity of this ſcience may be gathered from what was ſpoken by the Deity at the time of creating the celeſtial luminaries, "Let them be for ſigns and ſeaſons," &c. whence it is thought probable that the human race never exiſted without ſome knowledge of aſtronomy among them. Indeed, beſides the motives of mere curioſity, which of themſelves may be ſuppoſed to have excited people to a contemplation of the glorious celeſtial canopy, as far as that was poſſible, it is eaſily to be ſeen that ſome parts of the ſcience anſwer ſuch eſſential purpoſes to mankind, that they could not poſſibly be diſpenſed with.

1 Aſtronomy ſuppoſed to be underſtood by Adam and the Antediluvians.

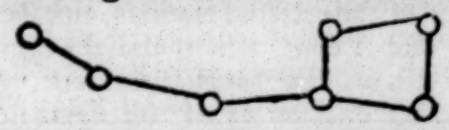
By ſome of the Jewiſh rabbins, Adam, in his ſtate of innocence, is ſuppoſed to have been endowed with a knowledge of the nature, influence and uſes of the heavenly bodies; and Joſephus aſcribes to Seth and his poſterity an extenſive knowledge of aſtronomy. But whatever may be in this, the long lives of the Antediluvians certainly afforded ſuch an excellent opportunity for obſerving the celeſtial bodies, that we cannot but ſuppoſe the ſcience of aſtronomy to have been conſiderably advanced before the flood. Joſephus ſays, that longevity was beſtowed upon them for the very purpoſe of improving the ſciences of geometry and aſtronomy. The latter could not be learned in leſs that 600 years: "for that period (ſays he) is the *grand year*." By which it is ſuppoſed he meant the period wherein the ſun and moon came again into the ſame ſituation as they were in the beginning thereof, with regard to the nodes, apogee of the moon, &c. "This period (ſays Caſſini), whereof we find no intimation in any monument of any other nation, is the fineſt period that ever was invented: for it brings out the ſolar year more exactly than that of Hipparchus and Ptolemy; and the lunar month within about one ſecond of what is determined by modern aſtronomers. If the Antediluvians had ſuch a period of 600 years, they muſt have known the motions of the ſun and moon more exactly than their deſcendants knew them ſome ages after the flood."

2 Aſtronomical knowledge of the Chineſe.

On the building of the tower of Babel, Noah is ſuppoſed to have retired with his children born after the flood, to the north-eaſtern part of Aſia, where his deſcendants peopled the vaſt empire of China. "This (ſays Dr Long) may perhaps account for the Chineſe having ſo early cultivated the ſtudy of aſtronomy; their being ſo well ſettled in an admirable police, and continuing ſo many hundred years as they did in the worſhip of the true God." The vanity of that people indeed has prompted them to pretend a knowledge of aſtronomy almoſt as early as the flood itſelf. Some of the Jeſuit miſſionaries have found traditional accounts among the Chineſe, of their having been taught this ſcience by their firſt emperor Fo-hi, ſuppoſed to be Noah; and Kempfer informs us, that this perſonage diſcovered the motions of the heavens, divided time into years and months, and invented the twelve ſigns into which they divide the zodiac, which they diſtinguiſh by the following

3 Their names for the ſigns of the zodiac.

following names. 1. The mouſe. 2. The ox or cow. 3. The tiger. 4. The hare. 5. The dragon. 6. The ſerpent. 7. The horſe. 8. The ſheep. 9. The monkey. 10. The cock or hen. 11. The dog; and, 12. The boar. They divide the heavens into 28 conſtellations, four of which are aſſigned to each of the ſeven planets; ſo that the year always begins with the ſame planet; and their conſtellations anſwer to the 28 manſions of the moon uſed by the Arabian aſtronomers. Theſe conſtellations in the Chineſe books of aſtronomy, are not marked by the figures of animals, as was in uſe among the Greeks, and from them derived to the other European nations, but by connecting the ſtars by ſtraight lines: and Dr Long informs us, that in a Chineſe book in thin 4to, ſhown him by Lord Pembroke, the ſtars were repreſented by ſmall circles joined by lines; ſo that the great bear would be marked thus,



To the emperor Hong-ti, the grandſon of Noah, they attribute the diſcovery of the pole-ſtar, the invention of the mariner's compaſs, of a period of 60 years, and ſome kind of ſphere. This extraordinary antiquity, however, is with good reaſon ſuſpected, as is likewiſe their knowledge in the calculation of eclipſes; of which Du Halde aſſures us, that 36 are recorded by Confucius himſelf, who lived 551 years before Chriſt; and P. Trigault, who went to China in 1619, and read more than 100 volumes of their annals, ſays, "It is certain that the Chineſe began to make aſtronomical obſervations ſoon after the flood; that they have obſerved a great number of eclipſes, in which they have noted down the hour, day, month, and year, when they happened, but neither the duration nor the quantity; and that theſe eclipſes have been made uſe of for regulating their chronology."

"But out of this abundance (ſays Dr Long), it is much to be regretted, that ſo very few of their obſervations have been particularized; for beſide what has been mentioned above, we meet with no very ancient obſervations of the Chineſe, except a winter ſolſtice in the year 1111, and a ſummer ſolſtice in the year 882, before Chriſt. Martini indeed ſpeaks of a ſummer ſolſtice 2342 years before that period. But M. Caſſini, who calculated it, found that there muſt have been an error in the Chineſe computation of 500 years at leaſt. An error of equal magnitude appears to have been committed in the conjunction of the five planets, which it is pretended the obſerved between the years 2513 and 2435 before Chriſt. In ſhort, ſome have ſuppoſed, that none of theſe are real obſervations, but the reſult of bungling calculations: and it has been hinted, but ſurely on too ſlight a foundation, that even thoſe good fathers themſelves were greatly to be ſuſpected. But let us come to things which are not conteſted.

"P. Gaubil informs us, that at leaſt 120 years before Chriſt, the Chineſe had determined by obſervation the number and extent of their conſtellations as they now ſtand; the ſituation of the fixed ſtars with reſpect to the equinoctial and ſolſtitial points; and the obliquity of the ecliptic. He farther ſays, he cannot tell by what means it is that they foretel eclipſes: but this is certain, that the theory by which they do predict them was ſettled about the ſame time; and that they were acquainted with the true length of the ſolar year, the method of obſerving meridian altitudes of the ſun by the ſhadow of a gnomon, and of learning from thence his declination and the height of the pole, long before. We learn, moreover, from the ſame miſſionary, that there are yet remaining among them ſome treatiſes of aſtronomy, which were written about 200 years before Chriſt; from which it appears, that the Chineſe had known the daily motion of the ſun and moon, and the times of the revolutions of the planets, many years before that period.

"We are informed by Du Halde, that, in the province of Honan, and city Teng-foang, which is nearly in the middle of China, there is a tower, on the top of which it is ſaid that *Tcheou-cong*, the moſt ſkilful aſtronomer that ever China produced, made his obſervations. He lived 1200 years before Ptolemy, or more than 1000 years before Chriſt, and paſſed whole nights in obſerving the celeſtial bodies and arranging them into conſtellations. He uſed a very large braſs table placed perfectly horizontal, on which was fixed a long upright plate of the ſame metal, both of which were divided into degrees, &c. By theſe he marked the meridian altitudes; and from thence derived the times of the ſolſtices, which were their principal epocha."

Dr Long repreſents the ſtate of aſtronomy in China as at preſent very low; occaſioned, he ſays, principally by the barbarous decree of one of their emperors*, to have all the books in the empire burnt, excepting ſuch as related to agriculture and medicine. We are informed, however, by the Abbe Groſier, in his deſcription of China, that aſtronomy is cultivated in Peking in the ſame manner as in moſt of the capital cities of Europe. A particular tribunal is eſtabliſhed there, the juriſdiction of which extends to every thing relating to the obſervation of celeſtial phenomena. Its members are, an inſpector; two preſidents, one of them a Tartar and the other a Chineſe; and a certain number of mandarins who perform the duty of aſſeſſors; but for near a century and an half the place of the Chineſe preſident has been filled by an European. Since that time particular attention has been paid to the inſtruction of the aſtronomical pupils; and the preſidents have always conſidered it as their duty to make them acquainted with the ſyſtem and method of calculation made uſe of in Europe. Thus two-thirds of the aſtronomical pupils, maintained at the emperor's expence, in all about 200, have a tolerable notion of the ſtate of the heavens, and underſtand calculation ſo well as to be able to compoſe ephemerides of ſufficient exactneſs. The miſſionaries have never been the authors of any of theſe ephemerides: their employment is to reviſe the labours of the Chineſe mathematicians, verify their calculations, and correct any errors into which they have fallen. The Portugueſe miſſion ſtill continues to furniſh aſtronomers for the academy as it did at the firſt.

The aſtronomical tribunal is ſubordinate to that of ceremonies. When an eclipſe is to be obſerved, information muſt be given to the emperor of the day and hour, the part of the heavens where it will be, &c. and this intelligence muſt be communicated ſome months before it happen; the eclipſe muſt alſo be calculated for the longitude and latitude of the capital city of every

* See China

every province of the empire. These observations, as well as the diagram which represents the eclipse, are preserved by the tribunal of ceremonies, and another called the *calao*, by whom it is transmitted to the different provinces and cities of the empire. Some days before the eclipse, the tribunal of ceremonies causes to be fixed up in a public place, in large characters, the hour and minute when the eclipse will commence, the quarter of the heavens in which it will be visible, with the other particulars relating to it. The mandarins are summoned to appear in state at the tribunal of astronomy, and to wait there for the moment in which the phenomenon will take place. Each of them carries in his hand a sheet of paper, containing a figure of the eclipse and every circumstance attending it. As soon as the observation begins to take place, they throw themselves on their knees, and knock their heads against the earth, and a horrid noise of drums and cymbals immediately commences throughout the whole city: a ceremony proceeding from an ancient superstitious notion, that by such noise they prevented the luminary from being devoured by the celestial dragon; and tho' this notion is now exploded in China, as well as every where else, such is the attachment of the people to ancient customs, that the ceremonial is still preserved. While the mandarins thus remain prostrated in the court, others, stationed on the observatory, examine, with all the attention possible, the beginning, middle, and end of the eclipse, comparing what they observe with the figure and calculations given. They then write down their observations, affix their seal to them, and transmit them to the Emperor; who on his part has been no less assiduous to observe the eclipse with accuracy. A ceremonial of this kind is observed throughout the whole empire.

The Japanese, Siamese, and inhabitants of the Mogul's empire, have also, from time immemorial, been acquainted with astronomy; and the celebrated observatory at BENARES, is a monument both of the ingenuity of the people and of their skill in this science.

4 Indian astronomy.

Mr. Bailly has been at great pains to investigate the progress of the Indians in astronomical knowledge, and gives a splendid account of their proficiency in the science, as well as of the antiquity of their observations. He has examined and compared four different astronomical tables of the Indian philosophers. 1. Of the Siamese, explained by M. Cassini in 1689. 2. Those brought from India by M. le Gentil of the Academy of Sciences. 3. and 4. Two other manuscript tables found among the papers of the late M. de Lisle. All of these tables have different epochs, and differ in form, being also constructed in different ways; yet they all evidently belong to the same astronomical system: the motions attributed to the sun and the moon are the same, and the different epochs are so well connected by the mean motions, as to demonstrate that they had only one, whence the others were derived by calculation. The meridians are all referred to that of Benares above mentioned. The fundamental epoch of the Indian astronomy is a conjunction of the sun and moon, which took place at no less a distance of time than 3102 years before the Christian æra. Mr Bailly informs us, that, according to our most accurate astronomical tables, a conjunction of the sun and moon actually did happen at that time. But though the brahmins pretend to have ascertained the places of the two luminaries at that time, it is impossible for us at this time to judge of the truth of their assertions, by reason of the unequal motion of the moon; which, as shall afterwards be more particularly taken notice of, now performs its revolution in a shorter time than formerly.

Our author informs us, that the Indians at present calculate eclipses by the mean motions of the sun and moon observed 5000 years ago; and with regard to the solar motion, their accuracy far exceeds that of the best Grecian astronomers. The lunar motions they had also settled by computing the space through which that luminary had passed in 1,600,984 days, or somewhat more than 4383 years. They also make use of the cycle of 19 years attributed by the Greeks to Meton; and their theory of the planets is much better than that of Ptolemy, as they do not suppose the earth to be the centre of the celestial motions, and they believe that Mercury and Venus turn round the sun. Mr Bailly also informs us, that their astronomy agrees with the most modern discoveries of the decrease of the obliquity of the ecliptic, the acceleration of the motion of the equinoctial points, with many other particulars too tedious to enumerate in this place.

5 Astronomy of the Americans.

It appears also, that even the Americans were not unacquainted with astronomy, though they made use only of the solar, and not of the lunar motions, in their division of time. The Mexicans have had a strange predilection for the number 13. Their shortest periods consisted of 13 days; their cycle of 13 months, each containing 20 days; and their century of four periods of 13 years each. This excessive veneration for the number 13, according to Siguenza, arose from its being supposed the number of their greater gods. What is very surprising, though asserted as a fact by Abbé Clavigero, is that having discovered the excess of a few hours in the solar above the civil year, they made use of intercalary days, to bring them to an equality: but with this difference in regard to the method established by Julius Cæsar in the Roman kalendar, that they did not interpose a day every four years, but 13 days (making use here even of this favorite number) every 52 years, which produces the same regulation of time.

6 Of the Chaldeans and Egyptians.

Among those nations who first began to make any figure in ancient history, we find the Chaldeans and Egyptians most remarkable for their astronomical knowledge. Both of them pretended to an extravagant antiquity, and disputed the honour of having been the first cultivators of the science. The Chaldeans boasted of their temple of Belus; and of Zoroaster whom they placed 5000 years before the destruction of Troy: the Egyptians boasted of their colleges of Priests, where astronomy was taught; and of the monument of Osymandyas, in which we are told was a golden circle 365 cubits in circumference and one cubit thick. The upper face was divided into 365 equal parts, answering to the days of the year; and on every division were written the name of the day, and the heliacal rising of the several stars for that day, with the prognostications from their rising, principally, as Long conjectures, for the weather.

The Chaldeans certainly began to make observations very soon after the confusion of languages; for when Alexander the Great took Babylon, Callisthenes,

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ASTRONOMY

Fig. 2

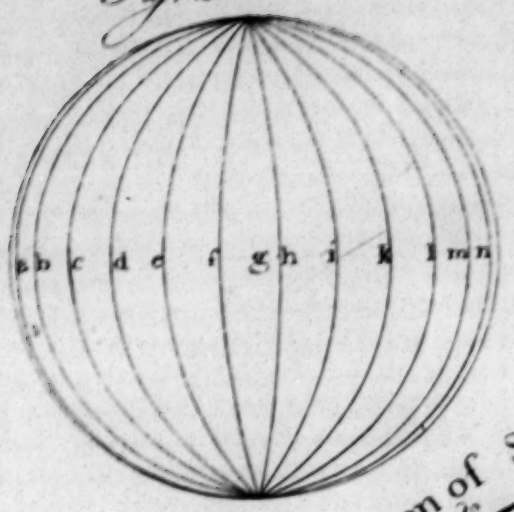


Fig. 3

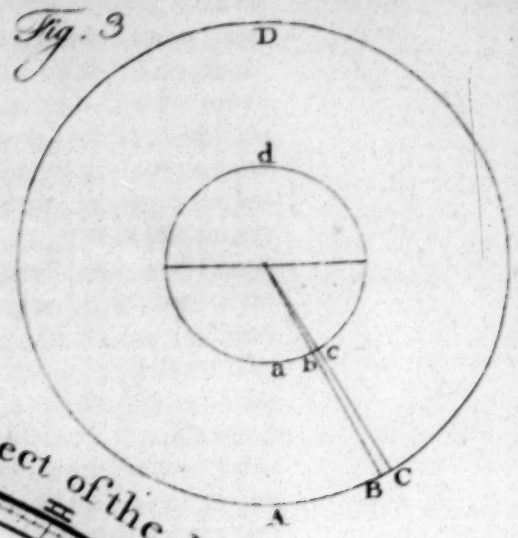


Fig. 1

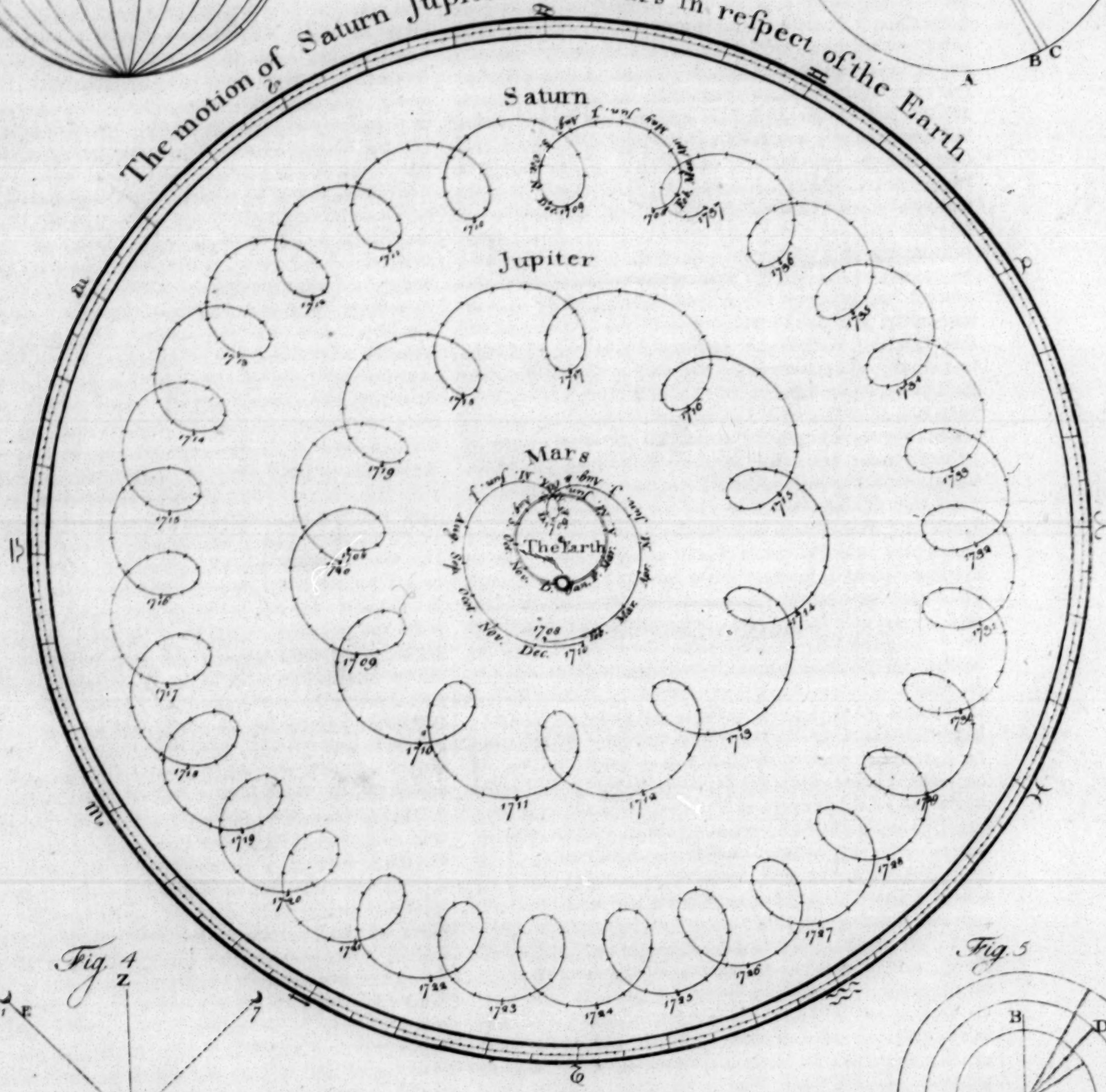

The motion of Saturn Jupiter and Mars in respect of the Earth

Fig. 4

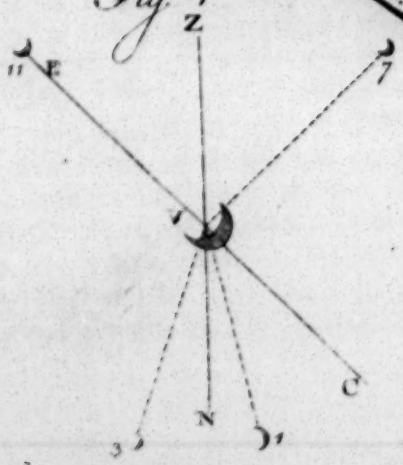
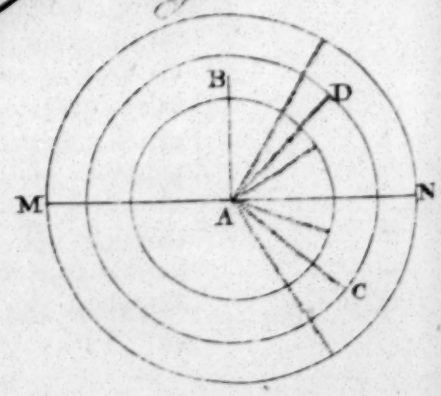


Fig. 5



Scot Philad^a

by his order, inquired after the aſtronomical obſervations recorded in that city, and obtained them for 1903 years back. Nothing, however, now remains of the Chaldean aſtronomy, excepting ſome periods of years which they had formed for the more ready computation of the heavenly bodies. But though they muſt have laboured under great diſadvantages, for want of proper inſtruments, in thoſe early ages, Gemina, as quoted by Petavius in his Uranologion, informs us, that they had determined, with tolerable exactneſs, the length both of a ſynodical and periodical month. They had alſo diſcovered, that the motion of the moon was not uniform, and even attempted to aſſign thoſe parts of her orbit in which it was quicker or ſlower. Ptolemy alſo aſſures us, that they were not unacquainted with the motion of the moon's nodes, and that of her apogee, ſuppoſing that the former made a complete revolution in 6585⅓ days, or 18 years 15 days and 8 hours; which period, containing 223 complete lunations, is called the Chaldean *Saros*. The ſame author alſo gives us, from Hipparchus, ſeveral obſervations of lunar eclipſes which had been made at Babylon about 720 years before Chriſt; but though he might very probably meet with many of a more ancient date, it was impoſſible to mention them particularly, on account of the imperfect ſtate of the Chaldean chronology, which commenced only with the æra of Nabonaſſar, 747 years before Chriſt. Ariſtotle likewiſe informs us, that they had many obſervations of the occultations of fixed ſtars and planets by the moon; and from hence, by a very natural and eaſy inference, they were led to conclude that the eclipſes of the ſun were occaſioned alſo by the moon, eſpecially as they conſtantly happened when the latter was in the ſame part of the heavens with the ſun. They had alſo a conſiderable ſhare in arranging the ſtars into conſtellations. Nor had the comets, by which aſtronomers in all ages have been ſo much perplexed, eſcaped their obſervation: for both Diodorus Siculus and Appollinus Myndius, in Seneca, informs us, that many of the Chaldeans held theſe to be laſting bodies, which have ſtated revolutions as well as the planets, but in orbits vaſtly more extenſive; on which account they are only ſeen by us while near the earth, but diſappear again when they go into the higher regions. Others of them were of opinion, that the comets were only meteors raiſed very high in the air, which blaze for a while, and diſappear when the matter of which they conſiſt is conſumed or diſperſed. Dialling was alſo known among them long before the Greeks were acquainted with any ſuch thing.

It is evident, indeed, that the countries both of Chaldea and Egypt were exceedingly proper for aſtronomical obſervations, on account of the general purity and ſerenity of the air. The tower or temple of Belus, which was of an extraordinary height, with ſtairs winding round it up to the top, is ſuppoſed to have been an aſtronomical obſervatory; and the loſty pyramids of Egypt, whatever they were originally deſigned for, might poſſibly anſwer the ſame purpoſe. Indeed theſe very ancient monuments ſhow the ſkill of this people in practical aſtronomy, as they are all ſituated with their four fronts exactly facing the cardinal points. Herodotus aſcribes the Egyptian knowledge in aſtronomy to Seſoſtris, whom Sir Iſaac Newton makes cotemporary with Solomon: but if this was the caſe, he could not be the inſtructor of the Egyptians in aſtronomical matters, ſince we find that Moſes, who lived 500 years before Solomon, was ſkilled in all the wiſdom of the Egyptians, in which we are undoubtedly to include aſtronomy.

From the teſtimony of ſome ancient authors, we learn that they believed the earth to be ſpherical, that they knew the moon was eclipſed by falling into its ſhadow, and that they made their obſervations with the greateſt exactneſs. They even pretended to foretel the appearance of comets, as well as earthquakes and inundations; which extraordinary knowledge is likewiſe aſcribed to the Chaldeans. They attempted to meaſure the magnitude of the earth and ſun; but the methods they took to find out the latter were very erroneous. It does not indeed appear with certainty that they had any knowledge of the true ſyſtem of the univerſe; and by the time of the Emperor Auguſtus, their aſtronomical knowledge was entirely loſt.

7 Of the Phenicians.

From Chaldea the ſcience of aſtronomy moſt probably paſſed into Phenicia; though ſame are of opinion that the Phenicians derived their knowledge of this ſcience from the Egyptians. They ſeem, however, to have been the firſt who applied aſtronomy to the purpoſes of navigation; by which they became maſters of the ſea, and of almoſt all the commerce in the world. They became adventurous in their voyages, ſteering their ſhips by one of the ſtars of the Little Bear; which being near the immoveable point of the heavens called the *Pole* is the moſt proper guide in navigation. Other nations made their obſervations by the Great Bear; which being too diſtant from the pole could not guide them in long voyages; and for this reaſon they never durſt venture far from the coaſts.

8 Aſtronomy of the Greeks.

The firſt origin of aſtronomical knowledge among the Greeks is unknown. Sir Iſaac Newton ſuppoſes that moſt of the conſtellations were invented about the time of the Argonautic expedition: but Dr Long is of opinion that many of them muſt have been of a much older date; and that the ſhepherds, who were certainly the firſt obſervers, gave names to them according to their fancy; from whence the poets invented many of their fables. Several of the conſtellations are mentioned by Heſiod and Homer, the two moſt ancient writers among the Greeks, who lived about 870 years before Chriſt; Heſiod deſiring the farmer to regulate the time of ſowing and harveſt by the riſing and ſetting of the Pleiades; and Homer informing us, that obſervations from the Pleiades, Orion, and Arcturus, were uſed in navigation.

9 Improved by Thales.

Their aſtronomical knowledge, however, was greatly improved by Thales the Mileſian, who travelled into Egypt, and brought from thence the firſt principles of the ſcience. He is ſaid to have determined the height of the pyramids by meaſuring their ſhadows at the time the ſun was 45 degrees high, and when of conſequence the lengths of the ſhadows of objects are equal to their perpendicular heights. But his reputation was raiſed to the higheſt pitch among his countrymen, by the prediction of an eclipſe, which happened juſt at the time that the armies of Alyattes king of Lydia, and Cyaxares the Mede, were about to engage; and being regarded as an evil omen by both parties, inclined them to

to peace. To him Callimachus attributes the forming of the conſtellation of the little bear; the knowledge of which he certainly introduced into Greece. He alſo taught the true length of the year; determined the coſmical ſetting of the Pleiades in his time to have been 25 days after the autumnal equinox; divided the earth into five zones by means of the polar circles and tropics; taught the obliquity of the ecliptic; and ſhowed that the equinoctial is cut by the meridians at right angles, all of which interſect each other at the poles. He is alſo ſaid to have obſerved the exact time of the ſolſtices, and from thence to have deduced the true length of the ſolar year; to have obſerved eclipſes of the ſun and moon; and to have taught that the moon had no light but what ſhe borrowed from the ſun. According to Stanley, he alſo determined the diameter of the ſun to be one-720th part of his annual orbit. "But (ſays Dr Long) theſe things ſhould be received with caution. There are ſome reaſons which might be aſſigned for ſuppoſing that the knowledge of Thales in theſe matters was much more circumſcribed: and indeed it is not unreaſonable to ſuppoſe, that that veneration for the ancients which leads authors to write profeſſedly on the hiſtory of ancient times, may have induced them to aſcribe full as much knowledge to thoſe who lived in them as was really their due."

10 By Anaximander, &c.

The ſucceſſors of Thales, Anaximander, Anaximanes, and Anaxagoras, contributed conſiderably to the advancement of aſtronomy. The firſt is ſaid to have invented or introduced the gnomon into Greece; to have obſerved the obliquity of the ecliptic; and taught that the earth was ſpherical, and the centre of the univerſe, and that the ſun was not leſs than it. He is alſo ſaid to have made the firſt globe, and to have ſet up a ſun-dial at Lacedemon, which is the firſt we hear of among the Greeks; though ſome are of opinion that theſe pieces of knowledge were brought from Babylon by Pherycides, a cotemporary of Anaximander. Anaxagoras alſo predicted an eclipſe which happened in the fifth year of the Peloponneſian war; and, taught that the moon was habitable, conſiſting of hills, valleys, and waters, like the earth.

11 Doctrines of Pythagoras.

His cotemporary Pythagoras, however, greatly improved not only aſtronomy and mathematics, but every other branch of philoſophy. He taught that the univerſe was compoſed of four elements, and that it had the ſun in the centre; that the earth was round, and had antipodes; and that the moon reflected the rays of the ſun; that the ſtars were worlds, containing earth, air, and ether; that the moon was inhabited like the earth; and that the comets were a kind of wandering ſtars, diſappearing in the ſuperior parts of their orbits, and becoming viſible only in the lower part of them. The white colour of the milky-way he aſcribed to the brightneſs of a great number of ſmall ſtars; and he ſuppoſed the diſtances of the moon and planets from the earth to be in certain harmonic proportions to one another. He is ſaid alſo to have exhibited the oblique courſe of the ſun in the ecliptic and the tropical circles, by means of an artificial ſphere; and he firſt taught that the planet Venus is both the evening and morning ſtar. This philoſopher is ſaid to have been taken priſoner by Cambyſes, and thus to have become acquainted with all the myſteries of the Perſian magi; after which he ſettled at Crotona in Italy, and founded the Italian ſect.

About 440 years before the Chriſtian æra, Philolaus, a celebrated Pythagorean, aſſerted the annual motion of the earth round the ſun; and ſoon after Hicetas, a Syracuſan, taught its diurnal motion on its own axis. About this time alſo flouriſhed Meton and Euctemon at Athens, who took an exact obſervation of the ſummer ſolſtice 432 years before Chriſt; which is the oldeſt obſervation of the kind we have, excepting what is delivered by the Chineſe. Meton is ſaid to have compoſed a cycle of 19 years, which ſtill bears his name; and he marked the riſings and ſettings of the ſtars, and what ſeaſons they pointed out: in all which he was aſſiſted by his companion Euctemon. The ſcience, however, was obſcured by Plato and Ariſtotle, who embraced the ſyſtem afterwards called the *Ptolemaic*, which places the earth in the centre of the univerſe.

Eudoxus the Cnidian was a cotemporary with Ariſtotle, though conſiderably older, and is greatly celebrated on account of his ſkill in aſtronomy. He was the firſt who introdced geometry into the ſcience, and he is ſuppoſed to be the inventor of many propoſitions attributed to Euclid. Having travelled into Egypt in the earlier part of his life, and obtained a recommendation from Ageſilaus to Nectanebus king of Egypt, he, by his means, got acceſs to the prieſts, who had the knowledge of aſtronomy entirely among them, after which he taught in Aſia and Italy. Seneca tells us that he brought the knowledge of the planetary motions from Egypt into Greece; and Archimedes, that he believed the diameter of the ſun to be nine times that of the moon. He was alſo well acquainted with the method of drawing a ſun-dial upon a plane; from whence it may be inferred that he underſtood the doctrine of the projection of the ſphere: yet, notwithſtanding what has been ſaid concerning the obſervations of Eudoxus, it is not certain that his ſphere was not taken from one much more ancient, aſcribed to Chiron the Centaur. The reaſon given for this ſuppoſition is, that had the places of the ſtars been taken from his own obſervations, the conſtellations muſt have been half a ſign farther advanced than they are ſaid to be in his writings.

Soon after Eudoxus, Calippus flouriſhed, whoſe ſyſtem of the celeſtial ſphere is mentioned by Ariſtotle; but he is better known from a period of 76 years, containing four corrected metonic periods, and which had its beginning at the ſummer ſolſtice in the year 330, before Chriſt. But about this time, or rather earlier, the Greeks having begun to plant colonies in Italy, Gaul, and Egypt, theſe became acquainted with the Pythagorean ſyſtem, and the notions of the ancient Druids concerning aſtronomy. Julius Cæſar informs us, that the latter were ſkilled in this ſcience; and that the Gauls in general were able ſailors, which at that time they could not be without a competent knowledge of aſtronomy: and it is related of Pythoas, who lived at Marſeilles in the time of Alexander the Great, that he obſerved the altitude of the ſun at the ſummer ſolſtice by means of a gnomon. He is alſo ſaid to have travelled as far as Thule to ſettle the climates.

12 State of aſtronomy in Egypt after the death of Alexander.

After the death of Alexander the Great, ſciences flouriſhed in Egypt more than in any other part of the world; and a famous ſchool was ſet up at Alexandria under the auſpices of Ptolemy Philadelphus, a prince inſtructed in all kinds of learning, and the patron of all

all thoſe who cultivated them; and this ſchool continued to be the ſeminary of all kinds of literature, till the invaſion of the Saracens in 650. Timocharis and Aryſtillus, who firſt cultivated the aſtronomical ſcience in this ſchool, began to put it on a new footing; being much more careful in their obſervations, and exact in noting down the times when they were made, than their predeceſſors. Ptolemy aſſures us, that Hipparchus made uſe of their obſervations, by means of which he diſcovered that the ſtars had a motion in longitude of about one degree in an hundred years; and he cites many of their obſervations, the oldeſt of which is before the erection of this ſchool, in the year 295, when the moon juſt touched the northern ſtar in the forehead of the ſcorpion; and the laſt of them was in the 13th year of Philadelphus, when Venus hid the former ſtar of the four in the left wing of Virgo.

From this time the ſcience of aſtronomy continued greatly to advance. Ariſtarchus, who lived about 270 years before Chriſt, ſtrenuouſly aſſerted the Pythagorean ſyſtem, and gave a method of determining the diſtance of the ſun by the moon's dichotomy. Eratoſthenes, born at Cyrene in 271 B. C. determined the meaſure of a great circle of the earth by means of a gnomon. His reputation was ſo great, that he was invited from Athens to Alexandria by Ptolemy Euergetes, and made by him keeper of the royal library at that place. At his inſtigation the ſame prince ſet up thoſe armillas or ſpheres, which Hipparchus and Ptolemy the aſtronomer afterwards employed ſo ſucceſsfully in obſerving the heavens. He alſo found the diſtance between the tropics to be eleven ſuch parts as the whole meridian contains eighty-three. About the ſame time Beroſus, a native of Chaldea, flouriſhed at Athens. He is by ſome ſaid to have brought many obſervations from Babylon, which are aſcribed to the Greeks; while others contend, that the latter owe little or nothing of their aſtronomical knowledge to the Babylonians. The celebrated Archimedes, who next to Sir Iſaac Newton holds the firſt place among mathematicians, was nothing inferior as an aſtronomer to what he was as a geometrician. He determined the diſtance of the moon from the earth, of Mercury from the moon, of Venus from Mercury, of the ſun from Venus, of Mars from the ſun, of Jupiter from Mars, and of Saturn from Jupiter; as likewiſe the diſtance of the fixed ſtars from the orbit of Saturn. That he made aſtronomical obſervations, is not to be doubted; and it appears from an epigram of the poet Claudian, that he invented a kind of planetarium, or orrery, to repreſent the phenomena and motions of the heavenly bodies.

13 Diſcoveries of Archimedes.

14 Of Hipparchus.

Hipparchus was the firſt who applied himſelf to the ſtudy of every part of aſtronomy, his predeceſſors having chiefly conſidered the motions and magnitudes of the ſun and moon. Ptolemy alſo informs us, that he firſt diſcovered the orbits of the planets to be eccentric, and on this hypotheſis wrote a book againſt Eudoxus and Calippus. He gives many of his obſervations; and ſays, that by comparing one of his with another made by Ariſtarchus 145 years before, he was enabled to determine the length of the year with great preciſion. Hipparchus alſo firſt found out the anticipation of the moon's nodes, the eccentricity of her orbit, and that ſhe moved ſlower in her apogee than in her perigee. He collected the accounts of ſuch ancient eclipſes as had been obſerved by the Chaldeans and Egyptians. He formed hypotheſes concerning the celeſtial motions, and conſtructed tables of thoſe of the ſun and moon, and would have done the ſame with thoſe of the other planets if he could have found ancient obſervations ſufficient for the purpoſe; but, theſe being wanting, he was obliged to content himſelf with collecting fit obſervations for that purpoſe, and endeavouring to form theories of the five planets. By comparing his own obſervations on the ſpica virginis with thoſe of Timochares at Alexandria made 100 years before, he diſcovered that the fixed ſtars changed their places, and had a ſlow motion of their own from weſt to eaſt. He corrected the Calippic period, and pointed out ſome errors in the method laid down by Eratoſthenes for meaſuring the circumference of the earth. By means of geometry, which was now greatly improved, he was enabled to attempt the calculation of the ſun's diſtance in a more correct manner than any of his predeceſſors; but unhappily it required ſo much accuracy in obſervation as was found impracticable. His greateſt work, however, was his catalogue of the fixed ſtars, which he was induced to attempt by the appearance of a new ſtar. The catalogue is preſerved by Ptolemy, and contains the longitudes and latitudes of 1022 ſtars, with their apparent magnitudes. He wrote alſo concerning the intervals between eclipſes both ſolar and lunar, and is ſaid to have calculated all that were to happen for no leſs than 600 years from his time.

15 Makes the firſt catalogue of fixed ſtars.

16 Syſtem of Ptolemy.

Little progreſs was made in aſtronomy from the time of Hipparchus to that of Ptolemy, who flouriſhed in the firſt century. The principles on which his ſyſtem is built are indeed erroneous; but his work will always be valuable on account of the number of ancient obſervations it contains. It was firſt tranſlated out of the Greek into Arabic in the year 827, and into Latin from the Arabic in 1230. The Greek original was unknown in Europe till the beginning of the 15th century, when it was brought from Conſtantinople, then taken by the Turks, by George a monk of Trapezond, who tranſlated it into Latin. Various editions were afterwards publiſhed; but little or no improvement was made by the Greeks in this ſcience.

17 Aſtronomy of the Arabians.

During the long period from the year 800 to the beginning of the 14th century, the weſtern parts of Europe were immerſed in deep ignorance and barbarity. However, ſeveral learned men aroſe among the Arabians. The caliph Al Manſur was the firſt who introduced a taſte for the ſciences in his empire. His grandſon Al Mamun, who aſcended the throne in 814, was a great encourager of the ſciences, and devoted much of his own time to the ſtudy of them. He made many aſtronomical obſervations himſelf, and determined the obliquity of the ecliptic to be 23° 35′. He employed many able mechanics in conſtructing proper inſtruments, which he made uſe of for his obſervations; and under his auſpices a degree of the earth was meaſured a ſecond time in the plain of Singar, on the border of the Red Sea. From this time aſtronomy was ſtudiouſly cultivated by the Arabians; and Elements of Aſtronomy were written by Alferganus, who was partly cotemporary with the caliph Al Mamun. But the moſt celebrated of all their aſtronomers is Albategnius,

nius, who lived about the year of Chriſt 880. He greatly reformed aſtronomy, by comparing his own obſervations with thoſe of Ptolemy. Thus he calculated the motion of the ſun's apogee from Ptolemy's time to his own; determined the preceſſion of the equinoxes to be one degree in 70 years; and fixed the ſun's greateſt declination at 23.35′. Finding that the tables of Ptolemy required much correction, he compoſed new ones of his own fitted to the meridian of Araćta, which were long held in eſtimation by the Arabians. After his time, though ſeveral eminent aſtronomers appeared among the Saracens, none made any very valuable obſervations for ſeveral centuries, excepting Ebn Younis aſtronomer to the caliph of Egypt: who obſerved three eclipſes with ſuch care, that by means of them we are enabled to determine the quantity of the moon's acceleration ſince that time.

Other eminent Saracen aſtronomers were, Arzachel a Moor of Spain, who obſerved the obliquity of the ecliptic, and conſtructed tables of ſines, or half chords of double arcs, dividing the diameter into 300 parts; and Alhazen, his cotemporary, who firſt ſhowed the importance of the theory of refractions in aſtronomy; writing alſo upon the twilight, the height of the clouds, and the phenomenon of the horizontal moon.

Ulug Beg, a grandſon of the famous Tartar prince Timur Beg, or Tamerlane, was a great proficient in practical aſtronomy. He is ſaid to have had very large inſtruments for making his obſervations; particularly a quadrant as high as the church of Sancta Sophia at Conſtantinople, which is 180 Roman feet. He compoſed aſtronomical tables from his own obſervations for the meridian of Samarcand his capital, ſo exact as to differ very little from thoſe afterwards conſtructed by Tycho Brache; but his principal work is his catalogue of the fixed ſtars, made from his own obſervations in the year of Chriſt 1437. The accuracy of his obſervations may be gathered from his determining the height of the pole at Samarcand to be 39° 37′ 23″.

Beſides theſe improvements, we are indebted to the Arabians for the preſent form of trigonometry. Manelaus, indeed, an eminent Greek aſtronomer who flouriſhed about the year 90, had publiſhed three books of Spherics, in which he treated of the geometry neceſſary to aſtronomy, and which ſhow great ſkill in the ſciences; but his methods were very laborious, even after they had been improved and rendered more ſimple by Ptolemy: but Geber the Arabian, inſtead of the ancient method, propoſed three or four theorems, which are the foundation of our modern trigonometry. The Arabians alſo made the practice ſtill more ſimple, by uſing ſines inſtead of the chords of double arcs. The arithmetical characters they had from the Indians.

18 Revival of aſtronomy in Europe.

During the greateſt part of this time, almoſt all Europe continued ignorant not only of aſtronomy but of every other ſcience. The emperor Frederick II. firſt began to encourage learning in 1230; reſtoring ſome univerſities, and founding a new one in Vienna. He alſo cauſed the works of Ariſtotle, and the Almageſt or Aſtronomical Treatiſe of Ptolemy, to be tranſlated into Latin; and from the tranſlation of this book we may date the revival of aſtronomy in Europe. Two years after this publication, John de Sacro Boſco, or of Halifax, an Engliſhman, wrote his four books *De Sphæra*, which he compiled from Ptolemy Albategnius, Alfraganus, and other Arabian aſtronomers: this work was ſo much celebrated, that for 300 years it was preferred in the ſchools to every other; and has been thought worthy of ſeveral commentaries, particularly by Clavius in 1531. In 1240, Alphonſo king of Caſtile cauſed the tables of Ptolemy to be corrected: for which purpoſe he aſſembled many perſons ſkilled in aſtronomy, Chriſtians, Jews, and Moors; by whom the tables called *Alphonſine* were compoſed, at the expence of 40,000, or according to others 400,000 ducats. About the ſame time Roger Bacon, an Engliſh monk, publiſhed many things relative to aſtronomy; particularly of the places of the fixed ſtars, ſolar rays, and lunar aſpects. Vitellio, a Polander, wrote a treatiſe on Optics about 1270, in which he ſhowed the uſe of refractions in aſtronomy.

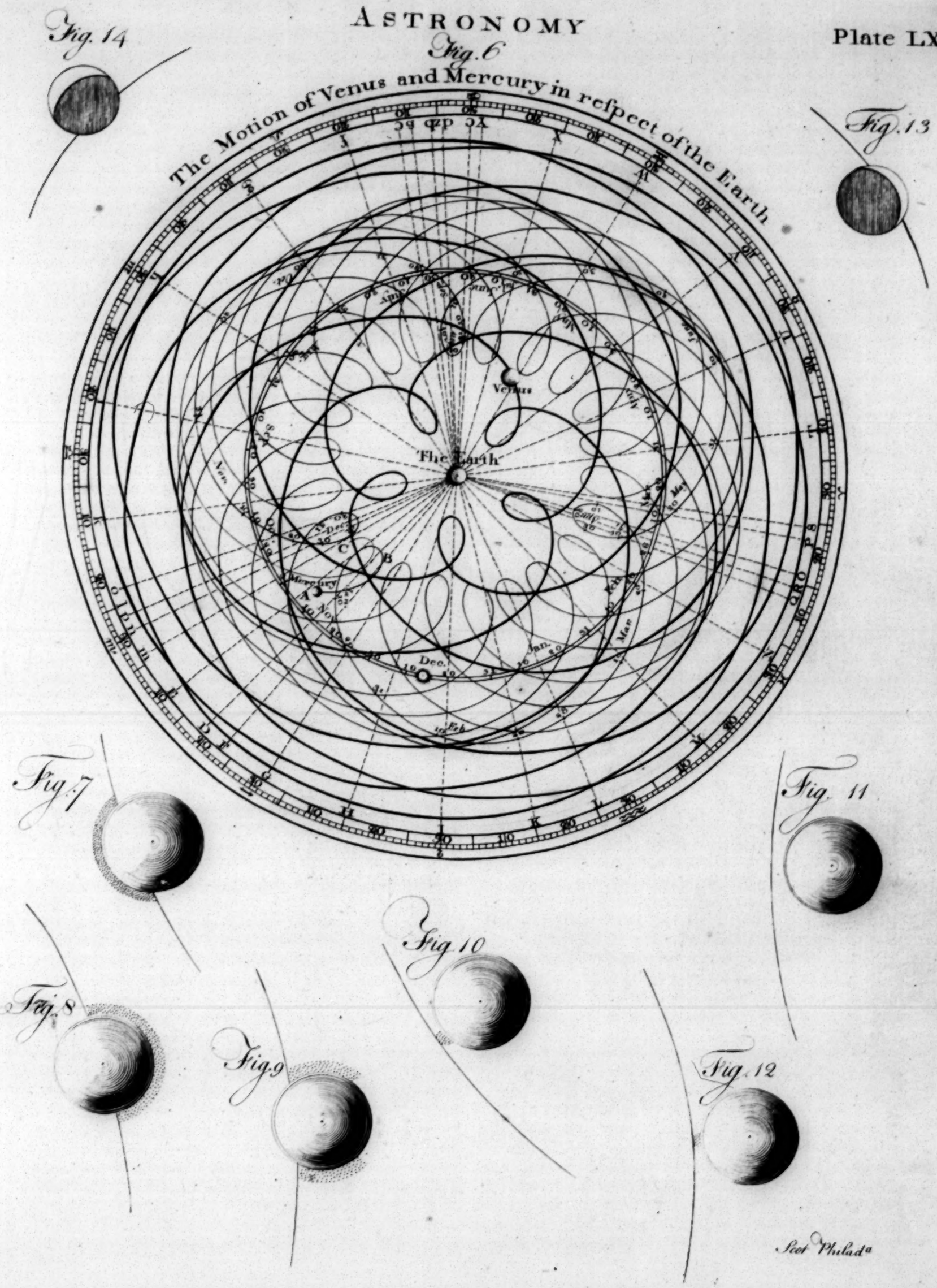
19 Improvements of Purbach.

From this time to that of Purbach; who was born in 1423, few or no improvements were made in aſtronomy. He wrote a commentary on Ptolemy's Almageſt, ſome treatiſes on Arithmetic and Dialling, with tables for various climates. He not only uſed ſpheres and globes, but conſtructed them himſelf; and formed new tables of the fixed ſtars, reduced to the middle of that age. He compoſed alſo new tables of ſines for every ten minutes, which Regiomontanus afterwards extended to every ſingle minute, making the whole ſine 60, with 6 ciphers annexed. He likewiſe corrected the tables of the planets, making new equations to them, becauſe the Alphonſine tables were very faulty in this reſpect. In his ſolar tables he placed the ſun's apogee in the beginning of Cancer; but retained the obliquity of the ecliptic 23° 33′, to which it had been reduced by the lateſt obſervations. He made new tables for computing eclipſes, of which he obſerved ſome, and had juſt publiſhed a theory of the planets, when he died in 1461.

20 Of Regiomontanus.

John Muller of Monteregio (Coningſberg), a town of Franconia, from whence he was called *Regiomontanus*, was the ſcholar and ſucceſſor of Purbach. He completed the epitome of Ptolemy's Almageſt which Purbach had begun; and after the death of the latter, went to Rome, where he made many aſtronomical obſervations. Having returned to Nuremberg in 1471, he was entertained by a wealthy citizen named *Bernard Walther*, who having a great love for aſtronomy, cauſed ſeveral inſtruments to be made under the direction of Regiomontanus, for obſerving the altitude of the ſun and ſtars, and other celeſtial phenomena. Among theſe was an armillary aſtrolabe, like that which had been uſed by Hipparchus and Ptolemy at Alexandria, and with which many obſervations were made. He alſo made ephemerides for 30 years to come, ſhowing the lunations, eclipſes, &c. He wrote the Theory of the Planets and Comets, and a Treatiſe of Triangles yet in repute for ſeveral extraordinary caſes. He is ſaid to have been the firſt who introduced the uſe of tangents into trigonometry; and to have publiſhed in print (the art of printing having been lately invented) the works of many of the moſt celebrated ancient aſtronomers. After his death, which happened at Rome, Walther made a diligent ſearch for all his inſtruments and papers which could be found; and continued his obſervations with the inſtruments he had till his death. The obſervations of both were collected by order of the ſenate of Nuremberg, and publiſhed

there



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there by John Schoner in 1544; afterwards by Snellius at the end of the obſervations made by the Landgrave of Heſſe in 1618; and laſtly, in 1666, with thoſe of Tycho Brache. Walther, however, as we are told by Snellius, found fault with his armilla, not being able to give any obſervation with certainty to leſs than ten minutes. He made uſe of a good clock, which alſo was a late invention in thoſe days.

21 Of Werner

John Werner, a clergyman, ſucceeded Walther as aſtronomer at Nuremberg; having applied himſelf with great aſſiduity to the ſtudy of that ſcience from his infancy. He obſerved the motion of the comet in 1500; and publiſhed ſeveral tracts, in which he handled many capital points of geometry, aſtronomy, and geography, in a maſterly manner. He publiſhed a tranſlation of Ptolemy's Geography, with a commentary, which is ſtill extant. In this he firſt propoſed the method of finding the longitude at ſea by obſerving the moon's diſtance from the fixed ſtars; which is now ſo ſucceſsfully put in practice. He alſo publiſhed many other treatiſes on mathematics and geography; but the moſt remarkable of all his treatiſes, are thoſe concerning the motion of the eighth ſphere or of the fixed ſtars, and a ſhort theory of the ſame. In this he ſhewed by comparing his own obſervations of the ſtars regulus, ſpica virginis, and the bright ſtar in the ſouthern ſcale of the balance, made in 1514, with the places aſſigned to the ſame ſtars by Ptolemy, Alphonſus, and others, that the motion of the fixed ſtars, now called *the preceſſion of the equinoctial points*, is one degree ten minutes in 100 years, and not one degree only, as former aſtronomers had made it. He made the obliquity of the ecliptic 23° 28′, and the firſt ſtar of Aries 26° diſtant from the equinoctial point. He alſo conſtructed a planetarium repreſenting the celeſtial motions according to the Ptolemaic hypotheſis, and made a great number of meteorological obſervations with a view towards the prediction of the weather. The obliquity of the ecliptic was ſettled by Dominic Maria, the friend of Copernicus, at 23° 29′, which is ſtill held to be juſt.

22 Pythagorean ſyſtem reſtored by Copernicus

The celebrated Nicholaus Copernicus next makes his apearance, and is undoubtedly the great reformer of the aſtronomical ſcience. He was originally bred to the practice of medicine, and had obtained the degree of Doctor in that faculty: but having conceived a great regard for the mathematical ſciences, eſpecially aſtronomy, he travelled into Italy, where he for ſome time was taught by Dominic Maria, or rather aſſiſted him in his aſtronomical operations. On his return to his own country, being made one of the canons of the church, he applied himſelf with the utmoſt aſſiduity to the contemplation of the heavens, and to the ſtudy of the celeſtial motions. He ſoon perceived the deficiency of all the hypotheſes by which it had been attempted to account for theſe motions; and for this reaſon he ſet himſelf to ſtudy the works of the ancients, with all of whom he alſo was diſſatisfied excepting Pythagoras; who, as has been already related, placed the ſun in the centre, and ſuppoſed all the planets, with the earth itſelf, to revolve round him. He informs us, that he began to entertain theſe notions about the year 1507; but not being ſatisfied with ſtating the general nature of his hypotheſis, he became deſirous of determining the ſeveral periodical revolutions of the planets, and thence of conſtructing tables of their motions which might be more agreeable to truth than thoſe of Ptolemy and Alphonſus. The obſervations he was enabled to make, however, muſt have been extremely inaccurate; as he tells us, that if with the inſtruments he made uſe of he ſhould be able to come within ten minutes of the truth, he would rejoice no leſs than Pythagoras did when he diſcovered the proportion of the hypothenuſe to the other two ſides of a right-angled triangle. His work was completed in the year 1530; but he could not be prevailed upon to publiſh it till towards the end of his life, partly through diffidence, and partly through fear of the offence which might be taken at the ſingularity of the doctrines ſet forth in it. At laſt, overcome by the importunities of his friends, he ſuffered it to be publiſhed at their expence; and under the inſpection of Schoner and Oſiander, with a dedication to Pope Paul III. and a preface, in which it was attempted to palliate as much as poſſible the extraordinary innovations it contained. During the time of its publication, the author himſelf was attacked by a bloody flux, ſucceeded by a palſy; ſo that he received a copy only a few hours before his death, which happened on the 23d of May 1543.

After the death of Copernicus, the aſtronomical ſcience was greatly improved by Schoner, Nonius, Appian, and Gemma Friſius. Schoner ſurvived Copernicus only four years; however, he greatly improved the methods of making celeſtial obſervations, reformed and explained the kalendar, and publiſhed a treatiſe of coſmography. Nonius had applied himſelf very early to the ſtudy of aſtronomy and navigation; but finding the inſtruments at that time in uſe exceſſively inaccurate, he applied himſelf to the invention of others which ſhould be leſs liable to inconvenience. Thus he invented the aſtronomical quadrant, in which he divided the degrees into minutes by a number of concentric circles. The firſt of theſe was divided into 90 equal parts, the ſecond into 89, the third into 88, and ſo on, as low as 46; and thus, as the index of the quadrant would always fall upon one or other of the diviſions, or very near it, the minutes might be known by computation. He publiſhed many treatiſes on mathematical ſubjects, particularly one which detected the errors of Orontius, who had imagined that he could ſquare the circle, double the cube, &c. by finding two mean proportionals betwixt two right lines. Appian's chief work was intitled *The Cæſarian Aſtronomy*; and was publiſhed at Ingoldſtadt in 1540, dedicated to the emperor Charles V. and his brother Ferdinand. In this he ſhowed how to reſolve aſtronomical problems by means of inſtruments, without either calculations or tables; to obſerve the places of the ſtars and planets by the aſtrolabe; and to foretel eclipſes and deſcribe the figures of them; the whole illuſtrated with proper diagrams. In his ſecond book he deſcribes the method of dividing an aſtronomical quadrant, and of uſing it properly. His treatiſe concludes with the obſervation of five comets. Gemma Friſius wrote a commentary on a work of Appian, intitled his *Coſmography*, with many obſervations of eclipſes. He invented alſo the aſtronomical ring, and ſeveral other inſtruments, which, though they could not boaſt of much exactneſs ſuperior to others, were yet of conſiderable utility in taking obſervations

at

at ſea; and he is alſo memorable for being the firſt who propoſed a time-keeper for determining the longitude at ſea.—George Joachim Rheticus was a ſcholar of Copernicus, to attend whoſe lectures he gave up his profeſſorſhip of mathematics at Wittemberg. For the improvement of aſtronomical calculations, he began to conſtruct a table of ſines, tangents, and ſecants, for every minute and ten ſeconds of the quadrant. In this work he firſt ſhowed the uſe of ſecants in trigonometry, and greatly enlarged the uſe of tangents, firſt invented by Regiomontanus; but he aſſigned for the radius a much larger number of places than had been done before, for the greater exactneſs of calculation. This great work he did not live to accompliſh; but it was completed by his diſciple Valentine Otho, and publiſhed at Heidelberg in 1594.

23 Several illuſtrious perſons apply to the ſtudy of aſtronomy.

During this century, the liſt of aſtronomers was dignified by ſome very illuſtrious names. About the year 1561, William IV. Landgrave of Heſſe Caſſel, applied himſelf to the ſtudy of aſtronomy. With the aſſiſtance of Rothman and Burgius, the former an aſtronomer, the latter an excellent mathematical inſtrument maker, he erected an obſervatory on the top of his palace at Caſſel, and furniſhed it with ſuch inſtruments as were then in uſe, made in the beſt manner the artiſts of that age could execute. With theſe he made a great number of obſervations, which were by Hevelius preferred to thoſe of Tycho-Brache, and which were publiſhed by Snellius in 1618. From theſe obſervations he determined the longitudes and latitudes of 400 ſtars, which he inſerted in a catalogue where their places are rectified to the beginning of the year 1593.

24 Obſervations of Tycho-Brache.

Tycho-Brache began his obſervations about the ſame time with the Landgrave of Heſſe, already mentioned. He obſerved the great conjunction of Saturn and Jupiter in 1563; and finding the inſtruments he could procure very inaccurate, he made a quadrant capable of ſhewing ſingle minutes, and likewiſe a ſextant four cubits radius. In 1571, he diſcovered a new ſtar in the chair of Caſſiopeia; which induced him, like Hipparchus, to make a catalogue of the ſtars. This contained the places of 777 ſtars, rectified to the year 1600; but inſtead of the moon, which was uſed by the ancients to connect the places of the ſun and ſtars, Tycho ſubſtituted Venus as having little or no parallax, and yet being like the moon viſible both day and night. By the recommendation of the Landgrave of Heſſe, he obtained from the king of Denmark the iſland of Huenna, oppoſite to Copenhagen, where an obſervatory was built. The firſt ſtone of this building, afterwards called *Uraniburg*, was laid in the year 1576. It was of a ſquare form, one ſide of it being about 60 feet in length; and on the eaſt and weſt ſides were two round towers of 32 feet diameter each. The inſtruments were more large and ſolid than had ever been ſeen before by any aſtronomer. They conſiſted of quadrants, ſextants, circles, ſemicircles, armillæ both equatorial and zodiacal, parallactic rulers, rings, aſtrolabes, globes, clocks, and ſun-dials. Theſe inſtruments were ſo divided as to ſhow ſingle minutes; and in ſome the arch might be read off to 10 ſeconds. Moſt of the diviſions were diagonal: but he had one quadrant divided according to the method invented by Nonius; that is, by 47 concentric circles. The whole expence is ſaid to have amounted to 200,000 crowns. The method of dividing by diagonals, which Tycho greatly admired, was the invention of Mr Richard Chanceller, an Engliſhman: Tycho, however, ſhows, that it is not accurately true when ſtraight lines are employed, and the circles at equal diſtances from each other; but that it may be corrected by making circular diagonals, which if continued would paſs through the centre.

25 Account of Uraniburg, his obſervatory.

Tycho employed his time at Uraniburg to the beſt advantage; but falling into diſcredit on the death of the king, he was obliged to remove to Holſtein, and at laſt found means to get himſelf introduced to the emperor, with whom he continued to his death. He is well known to have been the inventor of a ſyſtem of aſtronomy, which bears his name; and which he vainly endeavoured to eſtabliſh on the ruins of that of Copernicus; but the ſimplicity and evident conſonancy to the phenomena of nature, diſplayed in all parts of the Copernican ſyſtem, ſoon got the better of the unnatural and complicated ſyſtem of Tycho. His works, however, which are very numerous, diſcover him to have been a man of vaſt abilities. After his death the caſtle of Uraniburg quickly fell to decay, and indeed ſeems to have been purpoſely pulled down; for, in 1652, when Mr Huet went to Sweden, it was almoſt level with the ground, and few traces of the walls could be diſcerned. None of the neighbouring inhabitants had ever heard of the name of Tycho or Uraniburg, excepting one old man, whom Mr Huet found out with great difficulty, and who had been a ſervant in the family! All the diſcoveries of Purback, Regiomontanus, and Tycho, were collected and publiſhed in the year 1621, by Longomontanus, who had been Tycho's favourite ſcholar.

26 Diſcoveries of Kepler.

While Tycho reſided at Prague with the emperor, he invited thither John Kepler, afterwards ſo famous for his diſcoveries. Under the tuition of ſo great an aſtronomer, the latter quickly made an amazing progreſs. He found that his predeceſſors had erred in ſuppoſing the orbits of the planets to be circular, and their motions uniform: on the contrary, he perceived from his own obſervations, that they were elliptical, and their motions unequal, having the ſun in one of the foci of their orbits; but that, however, they varied in abſolute velocity, a line drawn from the centre of the ſun to the planet, and revolving with it, would always deſcribe equal areas in equal times. He diſcovered, in the year 1618, that the ſquares of the periodical times are as the cubes of the diſtances of the planets; two laws which have been of the greateſt importance to the advancement of aſtronomy. He ſeems to have had ſome notion of the extenſive power of the principle of gravity: for he tells us, that gravity is a mutual power betwixt two bodies; that the moon and earth tend towards each other, and would meet in a point nearer the earth than the moon in the proportion of the ſuperior magnitude of the former, were they not hindered by their projectile motions. He adds alſo, that the tides ariſe from the gravitation of the waters towards the moon: however, he did not adhere ſteadily to theſe principles, but afterwards ſubſtituted others as the cauſes of the planetary motions.

Cotemporary with Kepler were Mr Edward Wright, and Napier baron of Merchiſton. To the former we owe ſeveral very good meridional obſervations of the ſun's

ſun's altitude, made with a quadrant of ſix feet radius, in the years 1594, 1595, and 1596; from which he greatly improved the theory of the ſun's motion, and computed more exact tables of his declination than had been done by any perſon before. He publiſhed alſo in 1599, an excellent Treatiſe, entitled, "Certain Errors in Navigation diſcovered and detected." To the latter we are indebted for the knowledge of logarithms; a diſcovery, as was juſtly obſerved by Dr Halley, one of the moſt uſeful ever made in the art of numbering. John Bayer, a German, who lived about the ſame time, will ever be memorable for his work, entitled, *Uranometria*, which is a very complete celeſtial atlas, or a collection of all the conſtellations viſible in Europe. To this he added a nomenclature, in which the ſtars in each conſtellation are marked with the letters of the Greek alphabet; and thus every ſtar in the heavens may be referred to with the utmoſt preciſion and exactneſs. About the ſame time alſo, aſtronomy was cultivated by many other perſons; abroad, by Maginus, Mercator, Maurolycus, Homelius, Schultet, Stevin, &c.; and by Thomas and Leonard Digges, John Dee, and Robert Flood, in England; but none of them made any conſiderable improvement.

27 Invention of teleſcopes and conſequent diſcoveries.

The beginning of the 17th century was diſtinguiſhed not only by the diſcovery of logarithms, but by that of teleſcopes, a ſort of inſtruments by which aſtronomy was brought to a degree of perfection utterly inconceivable by thoſe who knew nothing of them. The queſtion concerning the inventor is diſcuſſed under the article OPTICS; but whoever was entitled to this merit, it is certain that Galileo was the firſt who brought them to ſuch perfection as to make any conſiderable diſcoveries in the celeſtial regions. With inſtruments of his own making, Galileo diſcovered the inequalities in the moon's ſurface, the ſatellites of Jupiter, and the ring of Saturn; though this laſt was unknown to him after he had ſeen it, and the view he got made him conclude that the planet had a threefold body, or that it was of an oblong ſhape like an olive. He diſcovered ſpots on the ſun, by means of which he found out the revolution of that luminary on his axis; and he diſcovered alſo that the milky way and nebulæ were full of ſmall ſtars. It was not, however, till ſome time after theſe diſcoveries were made that Galileo and others thought of applying the obſervations on Jupiter's ſatellites to the purpoſe of finding the longitude of places on the ſurface of the earth; and even after this was thought of, aſtronomers found it ſo difficult to conſtruct tables of their motions, that it was not till after many obſervations had been made in diſtant places of the world, that Caſſini was able to determine what poſitions of the ſatellites were moſt proper for finding out the longitude. At laſt he perceived that the entrance of the firſt ſatellite into the ſhadow of Jupiter, and the exit of it from the ſame, were the moſt proper for this purpoſe: that next to theſe the conjunctions of the ſatellites with Jupiter, or with one another, may be made uſe of; eſpecially when any two of them, moving in contrary directions, meet with each other: and laſtly, that obſervations on the ſhadows of the ſatellites, which may be ſeen on the diſk of Jupiter, are uſeful, as alſo the ſpots which are ſeen upon his face, and are carried along it with greater velocity than has hitherto been diſcovered in any of the other heavenly bodies.

While aſtronomers were thus buſy in making new diſcoveries, the mathematicians in different countries were no leſs earneſtly employed in conſtructing logarithmic tables to facilitate their calculations Benjamin Urſinus, an excellent mathematician of Brandenburg, calculated much larger tables of logarithms than had been done by their noble inventor, and publiſhed them in 1625. They were improved by Henry Briggs, Savilian profeſſor of Oxford; who by making unity the logarithm of ten, thus rendered them much more convenient for the purpoſes of calculation. Logarithmic tables of ſines and tangents were alſo compoſed by Mr Briggs and Adrian Vlacq at Goude, ſo that the buſineſs of calculation was now rendered nearly as eaſy as poſſible.

28 Logarithmic tables compoſed.

In 1633, Mr Horrox, a young aſtronomer of very extraordinary talents, diſcovered that Venus would paſs over the diſk of the ſun on the 24th of November 1639. This event he announced only to one friend, a Mr Crabtree; and theſe two were the only perſons in the world who obſerved this tranſit the firſt time it had ever been viewed by human eyes. Mr Horrox made many uſeful obſervations at the time; and had even formed a new theory of the moon, ſo ingenious as to attract the notice of Sir Iſaac Newton; but the hopes of aſtronomers from the abilities of this excellent young man were blaſted by his death in the beginning of January 1640.

29 Tranſit of Venus firſt diſcovered by Mr Horrox.

About the year 1638 many learned men began to aſſemble at Paris in order to hold conferences on different ſcientific ſubjects, which was the firſt foundation of the Royal Academy of Sciences in that capital. This practice was introduced in France by Merſennus, and ſoon after at London by Oldenburg; which laid the foundation of the Royal Society there. About this time alſo the celebrated aſtronomer Hevelius flouriſhed at Dantzic, building an obſervatory in his own houſe, and furniſhing it with excellent inſtruments of his own conſtruction; particularly octants and ſexants of braſs of three and four feet radius, as well as teleſcopes, with which he conſtantly obſerved the ſpots and phaſes of the moon, and from which obſervations he afterwards compiled his excellent and beautiful work intitled *Selenographia*. This noble building, together with all the books and inſtruments it contained, was conſumed by fire on the 26th of September 1679; but the memory, as well as the form and conſtruction of the inſtruments, is preſerved in a curious work of the ingenious inventor, intitled *Machina Cœleſtis*; though almoſt the whole impreſſion of this book was involved in the ſame fate with the inſtruments it deſcribes. The damage ſuſtained on this occaſion was eſtimated at 30,000 crowns.

30 Foundation of the academy of ſciences at Paris and Royal Society at London.

The celebrated Engliſh mechanic Dr Hooke, who was cotemporary with Hevelius, had in the mean time invented inſtruments with teleſcopic ſights, which he preferred to thoſe uſed by Hevelius ſo much, that a diſpute commenced, which procured Hevelius a viſit from Dr Halley. The latter had at that time taken a voyage to St Helena at the deſire of the Royal Society, in order to obſerve and form a catalogue of the ſtars in the ſouthern hemiſphere. The reſult of his obſervations with Hevelius's inſtruments was, that three ſeveral obſervations on the Spica Virginis and Regulus differed only a few ſeconds from each other. They were the invention of Tyco-Brache, and are

deſcribed

described under the article Optics. At this visit Halley and Hevelius observed on occultation of Jupiter by the moon, and determined the diameter of the latter to be 30′. 33″.

In 1671 the Royal Observatory in Paris was finished, and the use of it assigned to Mr Cassini, after it had been furnished with instruments at a very great expence: and the observatory at Greenwich being likewise built five years after, Mr Flamstead was appointed astronomer-royal. The observations in both these places, however, have been so numerous, that it is in vain to attempt any account of them.

31 Improvements in telescopes.

Before the middle of the 17th century the construction of telescopes had been greatly improved, particularly by Fontana and Huygens. The latter constructed one of 123 feet, which is still preserved in the museum of the Royal Society at London. With this he observed the moon and planets for a long time, and discovered that Saturn was encompassed with a ring. The French, however, still outdid the English artists; and by means of telescopes of 200 and 300 feet focus, M. Cassini was enabled to see all the five satellites of Saturn, his belts, and the shadows of Jupiter's satellites passing over his body. In 1666 M. Azout applied a micrometer to telescopes for the purpose of measuring the diameters of the planets, and small distances in the heavens; however an instrument of this kind had been before invented by Mr Gascoine, though it was but little known abroad.

Notwithstanding all these discoveries by means of telescopes, it was evident that they still continued in a very imperfect state, and their imperfections at the time appeared to be without remedy. One defect was the enormous length requisite to admit of any very considerable magnifying power; and another was the incorrectness of the image arising from the aberration of the rays, as was then supposed, by the spherical figure of the glass. To obviate these inconveniences, Mersennus is said to have first proposed, in a letter to Descartes, the use of reflectors instead of lenses in the construction of telescopes; but this he did in such an obscure manner, that the latter laboured to persuade him of the falsehood of the principle on which his scheme was founded. In 1663, however, James Gregory of Aberdeen showed how such a teloscope might be constructed. He showed also, that in order to form a perfect image of an object in this manner, the figure of the speculum ought to be parabolic; but Sir Isaac Newton, who applied himself to the framing of telescopes of the reflecting kind, found it impracticable to grind them of the desired figure. Laying aside the idea of reflecting telescopes, therefore, he applied himself to the execution of a scheme formed by Descartes, viz. that of grinding lenses of the figure of one of the conic sections. In prosecuting this plan, he discovered, that the greatest errors to which telescopes were subject arose from the different refrangibility of the rays of light, for which he could not then find any remedy. He therefore returned to the scheme he had just abandoned; and, in the year 1672, presented to the Royal Society two reflectors which were constructed with spherical speculums, as he could not procure any other. The inconveniences arising from the different refrangibility of the rays of light, have since been in the fullest manner corrected by Mr Dolland, the excellency of whose achromatic telescopes are too well known to need any encomium.

About the beginning of the present century, the practical part of astronomy seemed to languish for want of proper instruments. Roemer, indeed, had invented some new ones, and Dr Hooke had turned his attention towards this subject in a very particular manner; but either through want of skill in the artists, or some other unfortunate circumstance, it happened that nothing effectual was done. But at the very time when this was the case with practical astronomy, the speculative part was carried in a manner to its utmost pitch by the labours of the immortal Newton, whose Principia gave an entire new face to the science. It was not, however, for many years relished by the foreign philosophers, though almost immediately adopted at home, and has continued ever since to spread its reputation farther and farther, so that now it is in a manner established all over the world. "But (says Dr. Long) that, after Newton's system had for so long a time been neglected, it should all at once be universally received and approved of, is not to be attributed to chance, or the caprice of fashion, as some who are ignorant of it are apt to think; and from thence to expect that some other system will hereafter take its place and bury it in oblivion. The system of Newton, like that of Copernicus, is so agreeable to the phenomena of nature, and so well put together, that it *must* last as long as truth and reason endure, although time may perhaps bring the word attraction into disuse; and though it may no longer be thought inherent in matter, yet the laws of gravitation, as they are now called, and on which this system is founded, will never be forgotten.".

32 Astronomical instruments first improved in England

It was also in Britain that the first improvements in astronomical instruments took place. The celebrated mechanic and watchmaker Graham, carried the accuracy of his instruments to a degree which surprised every one. He also greatly improved the principles of watchwork, and made clocks to go with much greater regularity than before. The old eight feet mural arch at Greenwich was also constructed by him; as was a small equatorial sector for making observations out of the meridian: but he is chiefly remarkable for contriving the zenith sector of 24 feet radius, and afterwards one of 12½ feet, by which Dr Bradley discovered the aberration of the fixed stars. The reflecting telescope which had been invented by Gregory, and executed by Newton, was greatly improved by Mr Hadley, and a very complete and powerful instrument of that kind was presented to the Royal Society in 1719. The same gentleman has also immortalized his memory by the invention of the reflecting quadrant, which he presented to the Society in 1731, which is now in universal use at sea; and without which all improvements of the lunar theory would have been useless for determining the longitude, through the want of an instrument proper to make the observations with. It however appears, that an instrument, exactly similar to this in its principles, had been invented by Sir Isaac Newton; and a description of it, together with a drawing, given by the inventor to Dr Halley, when he was preparing for his voyage to discover the variation of the needle

needle in 1701. About the middle of this century, the conſtructing and dividing of large aſtronomical inſtruments was carried to a great degree of perfection by Mr John Bird: reflecting teleſcopes were equally improved by Mr Short, who firſt executed the divided object-glaſs micrometer. This had indeed been thought of by M. Louville, and ſeveral other perſons long before; and a deſcription of one nearly agreeing with that of Mr Short had been publiſhed in the Philoſophical Tranſactions for 1753: but had it not been for the great ſkill of Mr Short in figuring and centering glaſſes of this kind, it is very probable the ſcheme might never have been executed. About this time alſo Mr Dollond brought refracting teleſcopes to ſuch perfection, that they became ſuperior to reflectors of equal length; though all of them are now excelled by thoſe of Mr Herſchel, whoſe Teleſcopic diſcoveries have been far more numerous and ſurpriſing than thoſe of any other aſtronomer.

33 Improvements within this laſt century

We ſhall cloſe this hiſtory with a ſhort account of the labours of the principal aſtronomers ſince the building the Royal Obſervatories at Paris, Greenwich, and the appointment of Mr Flamſtead to the office of aſtronomer royal. This gentleman not only made obſervations on the ſun, moon, planets, and comets which appeared in his time, but on the fixed ſtars alſo, of which he gave a catalogue of 3000: many of them ſo ſmall that they cannot be diſcerned without the help of a teleſcope: he alſo publiſhed new ſolar tables, and a theory of the moon according to Horrox. He publiſhed a very curious tract on the doctrine of the ſphere, in which he ſhowed how to conſtruct eclipſes of the ſun and moon, as well as occultations of the fixed ſtars by the moon geometrically; and it was upon his obſervations that Halley's tables and Newton's theory of the moon were conſtructed. Mr Caſſini alſo diſtinguiſhed himſelf very conſiderably. He erected the gnomon, and drew the famous meridian line in the church of Petronia at Borunia. He enjoyed his office more than 40 years, making many obſervations on the ſun, moon, planets, and comets, and greatly amended the elements of their motions. The office was continued in his family, and his grandſon ſtill enjoys it. Rœmer, a celebrated Daniſh aſtronomer, firſt diſcovered the progreſſive motion of light by obſerving the eclipſes of Jupiter, and read a diſſertation upon it before the Royal Academy of Sciences at Paris in the year 1675. He was alſo the firſt who made uſe of a meridional teleſcope.

Mr Flamſtead was ſucceeded in 1719 by Dr Halley, "the greateſt aſtronomer (ſays M. de la Lande) without contradiction in England;" and, adds Dr Long, "I believe he might have ſaid in the whole world." He had been ſent, at the age of 21, by King Charles II. to the iſland of St Helena, in order to make a catalogue of the ſouthern ſtars, which was publiſhed in 1679. In 1705, he publiſhed his *Synopſis Aſtronomiæ Cometicæ*, in which, after immenſe calculation, he ventured to predict the return of one in 1758 or 1759. He alſo publiſhed many learned diſſertations in the Philoſophical Tranſactions concerning the uſe that might be made of the next tranſit of Venus in determining the diſtance of the ſun from the earth. He was the firſt who diſcovered the acceleration of the moon, and gave a very ingenious method of finding her parallax by three obſerved phaſes of a ſolar eclipſe. He compoſed tables of the ſun, moon, and all the planets; and, in the nine years in which he was at Greenwich, made near 1500 obſervations of the moon; all which he compared with the tables, and noted the differences; and theſe, he thought, would return in about 18 years. He recommended the method of determining the longitude by means of the moon's diſtance from the ſun and certain fixed ſtars. He was convinced of its ſuperior excellence; and it has ſince been adopted by all the moſt eminent aſtronomers in Europe. It is at preſent the only ſure guide to the mariner; and the great perfection to which it is now brought is much owing to the induſtry and exertions of Dr Maſkelyne, the preſent aſtronomer-royal, to whom we are indebted for the publication of the Nautical Almanac, the Requiſite Tables, and other works of the utmoſt ſervice to practical aſtronomy.

34 True figure of the earth diſcovered.

In the mean time an attempt was made in France to meaſure a degree of the earth, which occaſioned a very warm diſpute concerning the figure of it. Caſſini, from Picart's meaſure, concluded that the earth was an oblong ſpheroid; but Newton, from a conſideration of the laws of gravity and the diurnal motion of the earth, had determined the figure of it to be an oblate ſpheroid, and flatted at the poles. To determine this point, Lewis XV. reſolved to have two degrees of the meridian meaſured; one under, or very near the equator; and the other as near the pole as poſſible. For this purpoſe the Royal Academy of Sciences ſent M. Maupertuis, Clairault, Camus, and Le Monier, to Lapland. They were accompanied by the Abbé Outhier, a correſpondent of the ſame academy. They were joined by M. Celſius profeſſor of anatomy at Upſal; and having ſet out from France in the ſpring of the year 1736, returned to it in 1737, after having fully accompliſhed their errand. On the ſouthern expedition were diſpatched M. Godin, Condamine, and Bouguer, to whom the king of Spain joined Don George Juan and Don Anthony de Ulloa, two very ingenious gentlemen and officers of the marine. They left Europe in 1735; and after enduring innumerable hardſhips and difficulties in the execution of their commiſſion, returned to Europe at different times, and by different ways, in the years 1744, 1745, and 1746. The reſult of this arduous taſk was a confirmation of Newton's inveſtigation. Picart's meaſure was reviſed by Caſſini and De la Caille; and, after his errors were corrected, it was found to agree very well with the other two. On this occaſion too it was diſcovered, that the attraction of the great mountains of Peru had an effect on the plumb-line of one of their largeſt inſtruments, drawing it ſeven or eight ſeconds from the true perpendicular.

Dr Halley, dying in 1742, was ſucceeded by Dr Bradley, who, though inferior as a mathematician, greatly exceeded him as a practical aſtronomer. He was the firſt who made obſervations with an accuracy ſufficient to detect the leſſer inequalities in the motions of the planets and fixed ſtars. Thus he diſcovered the aberration of light, the nutation of the earth's axis, and was able to make the lunar tables much more perfect than they had ever been. He alſo obſerved the places, and computed the elements of the comets which appeared

peared in the years 1723, 1736, 1743, and 1757. He made new and moſt accurate tables of the motions of Jupiter's ſatellites, from his own obſervations and thoſe of Dr Pound; and from a multitude of obſervations of the ſun, moon, and ſtars, was enabled to give the moſt accurate table of mean refractions yet extant, as well as the beſt methods of computing the variations of thoſe refractions ariſing from the different ſtates of the air as indicated by the thermometer and barometer. In 1750, having procured a very large tranſit inſtrument made by Mr Bird, and a new mural quadrant of braſs eight feet radius, he began to make obſervations with redoubled induſtry; ſo that betwixt this time and his death, which happened in 1762, he made obſervations for ſettling the places of all the ſtars in the Britiſh catalogue, together with near 1500 places of the moon, much the greater part of which he compared with the tables of Mr Mayer.

35 Improvements by the French aſtronomers.

In the mean time the French aſtronomers were aſſiduous in their endeavours to promote the ſcience of aſtronomy. The theory of the moon, which had been given in a general way by Sir Iſaac Newton, began to be particularly conſidered by Meſſrs Clairault, D'Alembert, Euler, Mayer, Simpſon, and Walmſly; tho' Clairault, Euler, and Mayer, diſtinguiſhed themſelves beyond any of the reſt, and Mr Euler has been particularly happy in the arrangement of his tables for the eaſe and expedition of computation. He was excelled in exactneſs, however, by Mayer, who publiſhed his tables in the Gottingen Acts for 1753. In theſe the errors in longitude never exceeded two minutes; and having yet farther improved them, he ſent a copy to the lords of the Britiſh admiralty in 1755; and it was this copy which Dr Bradley compared with his obſervations, as already mentioned. His laſt corrections of them were afterwards ſent over by his widow; for which ſhe and her children received a reward of L.3000. Accurate tables for Jupiter's ſatellites were alſo compoſed by Mr Wargentin a moſt excellent Swediſh aſtronomer, and publiſhed in the Upſal Acts in 1741; which have ſince been corrected by the author in ſuch a manner as to render them greatly ſuperior to any ever publiſhed before.

36 Of M. de la Caille.

Amongſt the many French aſtronomers who contributed to the advancement of the ſcience, we are particularly indebted to M. de la Caille, for a moſt excellent ſet of ſolar tables, in which he has made allowances for the attractions of Jupiter, Venus, and the moon. In 1750 he went to the Cape of Good Hope, in order to make obſervations in concert with the moſt celebrated aſtronomers in Europe, for determining the parallax of the moon, as well as of the planet Mars, and from thence that of the ſun; from whence it appeared that the parallax of the ſun could not greatly exceed 10 ſeconds. Here he re-examined and adjuſted the places of the ſouthern ſtars with great accuracy, and meaſured a degree of the meridian at that place. In Italy the ſcience was cultivated with the greateſt aſſiduity by Signior Bianchini, father Boſcovich, Friſi, Manfredi, Zanotti, and many others; in Sweden by Wargentin already mentioned, Blingenſtern, Mallet, and Planman; and in Germany, by Euler elder and younger, Mayer, Lambert, Griſchow, &c. In the year 1760 all the learned ſocieties in Europe began to prepare for obſerving the tranſit of Venus over the ſun, foretold by Dr Halley upwards of 80 years before it happened, ſhowing at the ſame time the important uſe which might be made of it. Unfortunately, however, for the cauſe of ſcience, many of the aſtronomers ſent out to obſerve this phenomenon were prevented by unavoidable accidents from reaching the places of their deſtination, and others were diſappointed by the badneſs of the weather. It happened alſo, that the circumſtances of the phenomenon were much leſs favourable for the purpoſe of determining the ſun's parallax than had been expected by Dr Halley, owing to the faults of the tables he made uſe of: ſo that, notwithſtanding all the labours of aſtronomers at that time, they were not able to determine the matter; and even after their obſervations in 1769, when the circumſtances of the tranſit were more favourable, the parallax of the ſun remained ſtill uncertain.

Dr Bradley was ſucceeded in his office of aſtronomer-royal by Mr Bliſs Savilian profeſſor of aſtronomy at Oxford; who being in a very declining ſtate of health at the time of his acceſſion to the office, did not enjoy it long. He was ſucceeded by the learned Nevil Maſkelyne, D. D. the preſent aſtronomer-royal, whoſe name will be rendered immortal by his aſſiduity and ſucceſs in bringing the lunar method of determining the longitude at ſea into general practice.

Such was the general ſtate of aſtronomy, when Mr Herſchel's great diſcovery of augmenting the power of teleſcopes, beyond the moſt ſanguine hopes of aſtronomers, opened at once a ſcene altogether unlooked for. By this indefatigable obſerver we are made acquainted with a new primary planet attended by two ſecondaries belonging to our ſolar ſyſtem; ſo that the latter now appears to have double the bounds formerly aſſigned to it; this new planet being at leaſt twice the diſtance of Saturn from the ſun. In the ſtill farther diſtant celeſtial regions, among the fixed ſtars, his obſervations are equally ſurpriſing; of which we ſhall only ſay with Dr Prieſtley*, "Mr Herſchel's late diſcoveries in and beyond the bounds of the ſolar ſyſtem, the great views that he has given of the arrangement of the ſtars, their revolutions, and thoſe of the immenſe ſyſtems into which they are formed, are peculiarly calculated to inſpire an ardent deſire of ſeeing ſo great a ſcene a little more unfolded. Such diſcoveries as theſe give us a higher idea of the value of our being, by raiſing our ideas of the ſyſtem of which we are a part; and with this an earneſt wiſh for the continuance of it."

* *Exper. and Obſerv.* vol. vi. Pref.

SECT. I. *Of the apparent Motions, Magnitudes, and Changes, in the celeſtial Bodies, as ſeen by the naked eye.*

As the true motions of bodies at a great diſtance are to be gathered only from a careful obſervation of their apparent ones, it is abſolutely neceſſary for thoſe who want to become acquainted with the true motions of the heavenly bodies, to know perfectly the different changes which take place in the heavens as ſeen from this earth, the only place from which any obſervation

can

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can be made. By carefully attending to theſe, a little knowledge of optics will enable us to underſtand with great certainty not only the true ſyſtem of nature, but alſo what appearance the heavens would make to a ſpectator placed in any part of the viſible creation.

37 Apparent motion of the ſun.

The firſt and moſt obvious phenomenon is the daily riſing of the ſun in the eaſt, and his ſetting in the weſt; after which the moon and ſtars appear, ſtill keeping the ſame weſterly courſe, till we loſe ſight of them altogether. This cannot be long taken notice of before we muſt likewiſe perceive that neither the ſun nor moon always riſe exactly in the ſame point of the heavens. If we begin to obſerve the ſun, for inſtance, in the beginning of March, we will find that he ſeems to riſe almoſt every day ſenſibly more to the northward than he did the day before, to continue longer above the horizon, and to be more vertical at mid-day. This continues till towards the end of June, when he is obſerved to move backward in the ſame manner; and this retrograde motion continues to the end of December, or near it, when he begins again to move forwards, and ſo on.

38 Of the moon.

The motion of the moon through the heavens, as well as her appearance at different times, is ſtill more remarkable than thoſe of the ſun. When ſhe firſt becomes viſible at the time ſhe is called the *new moon*, ſhe appears in the weſtern part of the heavens, and ſeems to be at no great diſtance from the ſun himſelf. Every night ſhe not only increaſes in ſize, but removes to a greater diſtance from the ſun; till at laſt ſhe appears in the eaſtern part of the horizon, juſt at the time the ſun diſappears in the weſtern. After this ſhe gradually moves farther and farther eaſtward, and therefore riſes every night later and later, till at laſt ſhe ſeems to approach the ſun as nearly in the eaſt as ſhe did in the weſt, and riſes only a little before him in the morning, as in the firſt part of her courſe ſhe ſet in the weſt not long after him. All theſe different appearances are completed in the ſpace of a month; after which they begin in the ſame order as before. They are not, however, at all times regular; for at ſome ſeaſons of the year, particularly in harveſt, the moon for ſeveral days riſes nearly at the ſame hour every night.

39 Of the ſtars.

In contemplating the ſtars, it is obſerved that ſome of them have the ſingular property of neither riſing in the eaſt nor ſetting in the weſt; but ſeem to turn round one immoveable point, near which is placed a ſingle ſtar called the *pole*, or *pole-ſtar*. This point is more or leſs elevated according to the different parts of the earth from which we take our view. The inhabitants of Lapland, for inſtance, ſee it much more elevated above the horizon, or more vertical, than we do; we ſee it more vertical than it appears to the inhabitants of France and Spain; and they, again, ſee it more elevated than the inhabitants of Barbary. By continually travelling ſouth, this ſtar would at length ſeem depreſſed in the horizon, and another point would appear directly oppoſite to it, round which the ſtars in the ſouthern part of the horizon would ſeem to turn. In this part of the heavens, however, there is no ſtar ſo near the pole as there is in the northern part; neither is the number of ſtars in the ſouthern part of the heavens ſo great as in the northern. Suppoſing us ſtill to travel ſouthward, the north-pole would then entirely diſappear, and the whole hemiſphere would appear to turn round a ſingle point in the ſouth, as the northern hemiſphere appears to us to turn round the pole-ſtar.— The general appearance of the heavens, therefore, is that of a vaſt concave ſphere, turning round two points fixed in the north and ſouth parts of it, once in 24 hours.

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40 Fixed ſtars and planets.

When we further conſider the ſtars, we will find the greateſt part of them to keep their places with reſpect to one another; that is, if we obſerve two ſtars having a certain apparent diſtance from each other this night, they will ſeem to have the ſame to-morrow, and every other ſucceeding night; but we will by no means obſerve them to have the ſame places either with reſpect to the ſun or moon, as muſt be eaſily underſtood from what we have already ſaid. Neither do all the ſtars in the heavens appear to be of this fixed kind. Some of them, on the contrary, change their places very remarkably with regard to the fixed ſtars, and with regard to one another. Of theſe, five were only obſerved formerly; but Mr Herſchel has now diſcovered a ſixth. They are diſtinguiſhed by the appellation of *planets*, (from πλανο, to *err* or *wander*); and called by the names of *Mercury*, *Venus*, *Mars*, *Jupiter*, *Saturn*, and the *Georgium Sidus*. The fixed ſtars are likewiſe diſtinguiſhed from the planets by their continually exhibiting that appearance which is called the *ſcintillation* or *twinkling of the ſtars*. This is ſaid to ariſe from the exceeding minuteneſs of their apparent diameter; ſo that the interpoſition of any little ſubſtance, of which there are many floating in the atmoſphere, continually deprives us of the ſight of them; but the interpoſing body ſoon changing its place, we again ſee the ſtar, and thus the twinkling is produced.

Mercury is a ſmall ſtar, but emits a very bright white light; though by reaſon of his always keeping near the ſun, he is ſeldom to be ſeen; and when he does makes his appearance, his motion towards the ſun is ſo ſwift, that he can only be diſcerned for a ſhort time. He appears a little after ſunſet, and again a little before ſunriſe.

Venus, the moſt beautiful ſtar in the heavens, known by the names of the *morning* and *evening ſtar*, likewiſe keeps near the ſun, though ſhe recedes from him almoſt double the diſtance of mercury. She is never ſeen in the eaſtern quarter of the heavens when the ſun is in the weſtern; but always ſeems to attend him in the evening, or to give notice of his approach in the morning.

Mars is of a red fiery colour, and always gives a much duller light than Venus, though ſometimes he equals her in ſize. He is not ſubject to the ſame limitation in his motions as Mercury or Venus; but appears ſometimes very near the ſun, and ſometimes at a great diſtance from him; ſometimes riſing when the ſun ſets, or ſetting when he riſes. Of this planet it is remarkable, that when he approaches any of the fixed ſtars, which all the planets frequently do, theſe ſtars change their colour, grow dim, and often become totally inviſible, though at ſome little diſtance from the body of the planet: but Mr Herſchel thinks this has been exaggerated by former aſtronomers.

Jupiter and Saturn likewiſe often appear at great diſtances from the ſun. The former ſhines with a bright white light, and the latter with a pale faint one: and

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the motion of Saturn among the fixed ſtars is ſo ſlow, that, unleſs carefully obſerved, he will not be thought to move at all.

41 Apparent magnitudes of the planets different at different times.

Beſides the motions which we obſerve in all theſe planets, their apparent magnitudes are very different at different times. Every perſon muſt have obſerved that Venus, though ſhe conſtantly appears with great ſplendor is not always equally big; and this apparent difference of magnitude is ſo remarkable, that ſhe appears no leſs than 32 times larger at ſome ſeaſons than at others. This increaſe of magnitude is likewiſe very remarkable in Mars and Jupiter, but leſs ſo in Saturn and Mercury.

42 Their irregular motion.

Though we have thus deſcribed the motions of the planets with reſpect to their apparent diſtances from the ſun, they by no means appear to us to move regularly in the heavens; but, on the contrary, in the moſt complex and confuſed manner that can be imagined, ſometimes going forward, ſometimes backward, and ſometimes ſeeming to be ſtationary. They all ſeem to deſcribe looped curves; but it is not known when any of theſe curves would return into themſelves, except that of Venus, which returns nearly into itſelf every eighth year. On each ſide of the loops they appear ſtationary; in that part of each loop near the earth, retrograde; and in every other part of their path direct.

43 Comets.

Theſe, however, are not the only moving bodies which are to be obſerved in the celeſtial regions. The ſix abovementioned are indeed the only ones which appear almoſt conſtantly, or diſappear only at certain intervals, and then as certainly return. But there are others which appear at uncertain intervals, and with a very different aſpect from the planets. Theſe are very numerous, and no fewer than 450 are ſuppoſed to belong to our ſolar ſyſtem. They are called *Comets*, from their having a long tail, ſomewhat reſembling the appearance of hair. This, however, is not always the caſe; for ſome comets have appeared which were as well defined and as round as planets: but in general they have a luminous matter diffuſed around them, or projecting out from them, which to appearance very much reſembles the Aurora Borealis. When theſe appear, they come in a direct line towards the ſun, as if they were going to fall into his body; and after having diſappeared for ſome time in conſequence of their proximity to that luminary, they fly off again on the other ſide as faſt as they came, projecting a tail much greater and brighter in their receſs from him than when they advanced towards him; but, getting daily at a farther diſtance from us in the heavens, they continually loſe of their ſplendor, and at laſt totally diſappear. Their apparent magnitude is very different: ſometimes they appear only of the bigneſs of the fixed ſtars; at other times they will equal the diameter of Venus, and ſometimes even of the ſun or moon. So, in 1652, Hevelius obſerved a comet which ſeemed not inferior to the moon in ſize, though it had not ſo bright a ſplendor, but appeared with a pale and dim light, and had a diſmal aſpect. Theſe bodies will alſo ſometimes loſe their ſplendor ſuddenly, while their apparent bulk remains unaltered. With reſpect to their apparent motions, they have all the inequalities of the planets; ſometimes ſeeming to go forwards, ſometimes backwards, and ſometimes to be ſtationary.

Though the fixed ſtars are the only marks by which aſtronomers are enabled to judge of the courſes of the moveable ones, and though they have never been obſerved to change their places; yet they ſeem not to be endued with the permanency even of the earth and planets, but to be periſhable or deſtructible by accident, and likewiſe generable by ſome natural cauſe. Several ſtars obſerved by the ancients are now no more to be ſeen, but are deſtroyed; and new ones have appeared, which were unknown to the ancients. Some of them have alſo diſappeared for ſome time, and again become viſible.

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44 Fixed ſtars ſeemingly deſtructible and generable.

We are alſo aſſured from the obſervations of aſtronomers, that ſome ſtars have been obſerved which never were ſeen before, and for a certain time they have diſtinguiſhed themſelves by their ſuperlative luſtre; but afterwards decreaſing, they vaniſhed by degrees, and were no more to be ſeen. One of theſe ſtars being firſt ſeen and obſerved by Hipparchus, the chief of the ancient aſtronomers, ſet him upon compoſing a catalogue of the fixed ſtars, that by it poſterity might learn whether any of the ſtars periſh, and others are produced afreſh.

After ſeveral ages another new ſtar appeared to Tycho Brache and the aſtronomers who were cotemporary with him; which put him on the ſame deſign with Hipparchus, namely, the making a catalogue of the fixed ſtars. Of this, and other ſtars which have appeared ſince that time, we have the following hiſtory by Dr Halley: "The firſt new ſtar in the chair of Caſſiopeia, was not ſeen by Cornelius Gemma on the 8th of November 1572, who ſays, he that night conſidered that part of the heaven in a very ſerene ſky, and ſaw it not: but that the next night, November 9, it appeared with a ſplendor ſurpaſſing all the fixed ſtars, and ſcarce leſs bright than Venus. This was not ſeen by Tycho Brache before the 11th of the ſame month: but from thence he aſſures us that it gradually decreaſed and died away, ſo as in March 1574, after ſixteen months, to be no longer viſible; and at this day no ſigns of it remain. The place thereof in the ſphere of fixed ſtars, by the accurate obſervations of the ſame Tycho, was 0ˢ 9° 17′ *a* 1ᵐᵃ ✱ ♈ⁱˢ, with 53° 45′ north latitude.

45 Dr Halley's hiſtory of new ſtars.

"Such another ſtar was ſeen and obſerved by the ſcholars of Kepler, to begin to appear on Sept. 30. *ſt. vet.* anno 1604, which was not to be ſeen the day before: but it broke out at once with a luſtre ſurpaſſing that of Jupiter; and like the former, it died away gradually, and in much about the ſame time diſappeared totally, there remaining no footſteps thereof in January 1605—6. This was near the ecliptic, following the right leg of Serpentarius; and by the obſervations of Kepler and others, was in 7ˢ 20° 00′ *a* 1ᵐᵃ ✱ ♈, with north latitude 1° 56′. Theſe two ſeem to be of a diſtinct ſpecies from the reſt, and nothing like them has appeared ſince.

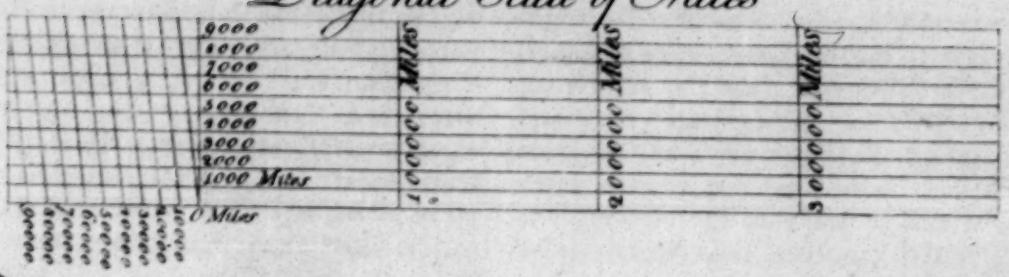
"But between them, viz. in the year 1596, we have the firſt account of the wonderful ſtar in Collo Ceti, ſeen by David Fabricius on the third of Auguſt, *ſt. vet.* as bright as a ſtar of the third magnitude which has been ſince found to appear and diſappear periodically, its

Fig. 15

THE SUN

with the GREAT SPOT *in 1769*

Diagonal Scale of Miles



Jupiter & his Satellites

Fig. 18

Distance of the 4th Satellite from the third

Mercury

Venus

Mars

Earth *Moon*

Distance of the Moon from the Earth

Saturn & his Satellites

Fifth Satellite thrice the distance of the fourth

Fig. 16

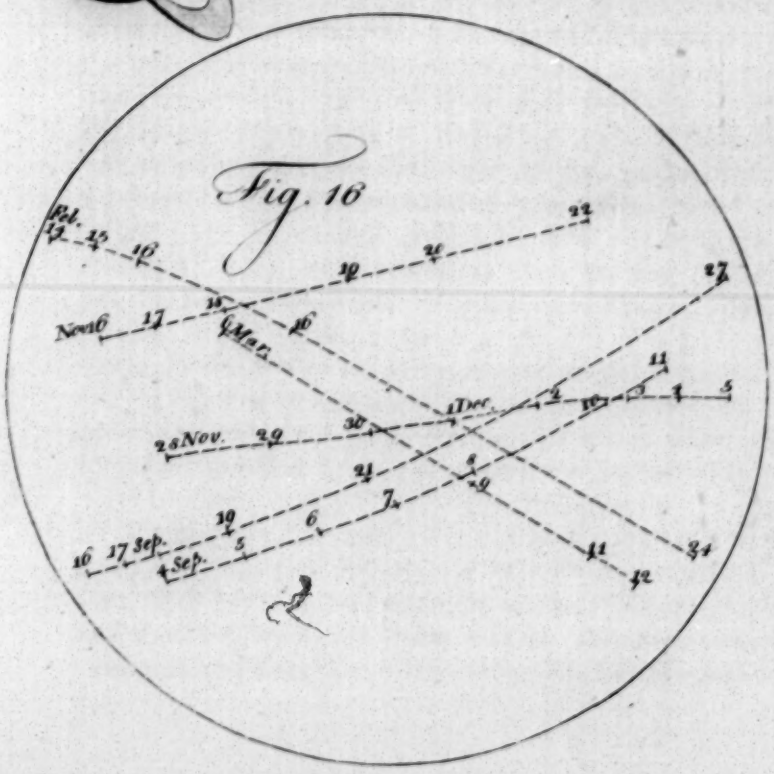
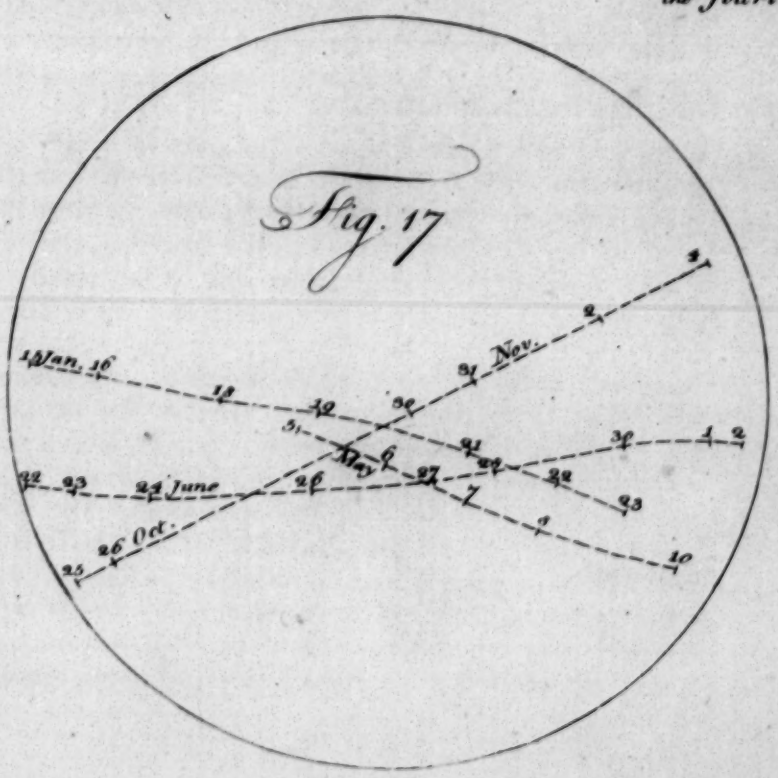


Fig. 17



Peet Philad.a

BRITISH MUSEUM

Apparent Motion, &c.

its period being preciſely enough ſeven revolutions in ſix years, though it returns not always with the ſame luſtre. Nor is it ever totally extinguiſhed, but may at all times be ſeen with a ſix-feet tube. This was ſingular in its kind, till that in Collo Cygni was diſcovered. It precedes the firſt ſtar in Aries 1° 40′, with 15° 57′ ſouth latitude.

"Another new ſtar was firſt diſcovered by William Janſonius in the year 1600, *in pectore*, or rather *in eductione*, Colli Cygni, which exceeded not the third magnitude. This having continued ſome years, became at length ſo ſmall, as to be thought by ſome to have diſappeared entirely: but in the years 1657, 1658, and 1659, it again aroſe to the third magnitude; tho' ſoon after it decayed by degrees to the fifth or ſixth magnitude, and to this day is to be ſeen as ſuch in 9ˢ 18° 38′ *a* 1ᵐᵃ * ♈, with 55° 29′ north latitude.

"A fifth new ſtar was firſt ſeen by Hevelius in the year 1670, on July 15. *ſt. vet.* as a ſtar of the third magnitude, but by the beginning of October was ſcarce to be perceived by the naked eye. In April following it was again as bright as before, or rather greater than of the third magnitude, yet wholly diſappeared about the middle of Auguſt. The next year, in March 1672, it was ſeen again, but not exceeding the 6th magnitude: ſince when, it has been no further viſible, though we have frequently ſought for its return; its place is 9ˢ 3° 17′ *a* 1ᵐᵃ * ♈, and has lat. north 47° 28′.

"The ſixth and laſt is that diſcovered by Mr G. Kirch in the year 1686, and its period determined to be of 404½ days; and though it rarely exceeds the fifth magnitude, yet it is very regular in its returns, as we found in the year 1714. Since then we have watched, as the abſence of the moon and clearneſs of the weather would permit, to catch the firſt beginning of its appearance in a ſix-feet tube, that, bearing a very great aperture, diſcovers moſt minute ſtars. And on June 15, laſt, it was firſt perceived like one of the very leaſt teleſcopical ſtars: but in the reſt of that month and July, it gradually increaſed, ſo as to become in Auguſt viſible to the naked eye; and ſo continued all the month of September. After that, it again died away by degrees; and on the eighth of December, at night, was ſcarce diſcernible by the tube; and, as near as could be gueſſed, equal to what it was at its firſt appearance on June 25th: ſo that this year it has been ſeen in all near ſix months, which is but little leſs than half its period; and the middle, and conſequently the greateſt brightneſs, falls about the 10th of September."

46 Mr Montanere's account of changes among the fixed ſtars.

Concerning the changes which happen among the fixed ſtars, Mr Montanere, profeſſor of mathematics at Bononia, gave the following account, in a letter to the Royal Society, dated April 30th, 1670. "There are now wanting in the heavens two ſtars of the ſecond magnitude in the ſtern of the ſhip Argo, and its yard; Bayerus marked them with the letters β and γ. I and others obſerved them in the year 1664, upon the occaſion of the comet that appeared that year: when they diſappeared firſt, I know not: only I am ſure that in the year 1668, upon the 10th of April, there was not the leaſt glimpſe of them to be ſeen; and yet the reſt about them, even of the third and fourth magnitudes, remained the ſame. I have obſerved many more changes among the fixed ſtars, even to the number of an hundred, though none of them are ſo great as thoſe I have ſhowed."

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The late improvements in aſtronomy, and particularly thoſe in the conſtruction of teleſcopes, have now given aſtronomers an opportunity of obſerving the changes which take place among the ſtars with much greater accuracy than could be formerly done. In a paper in the 76th volume of the Philoſophical Tranſactions, Mr Edward Pigot gives a diſſertation on the ſtars ſuſpected by the aſtronomers of laſt century to be changeable. For the greater accuracy in the inveſtigation of his ſubject, he divides them into two claſſes; one containing thoſe which are undoubtedly changeable, and the other thoſe which are only ſuſpected to be ſo. The former contains a liſt of 12 ſtars, from the firſt to the fourth magnitudes; including the new one which appeared in Caſſiopeia in 1572, and that in Serpentarius in 1604: the other contains the names of 38 ſtars of all magnitudes, from the firſt to the ſeventh. He is of opinion, that the celebrated new ſtar in Caſſiopeia is a periodical one, and that it returns once in 150 years. Mr Keill is of the ſame opinion; and Mr Pigot thinks, that its not being obſerved at the expiration of each period is no argument againſt the truth of that opinion; "ſince (ſays he), perhaps, as with moſt of the variable, it may at different periods have different degrees of luſtre, ſo as ſometimes only to increaſe to to the ninth magnitude; and if this ſhould be the caſe, its period is probably much ſhorter." For this reaſon, in September 1782, he took a plan of the ſmall ſtars near the place where it formerly appeared, but in four years had obſerved no alteration.

47 Mr Pigot's remarks on the accounts of variable ſtars.

48 Star in Collo Celi.

The ſtar in the neck of the Whale had alſo been examined by Mr Pigot from the end of 1782 to 1786, but he never found it exceed the ſixth magnitude; though Mr Goodricke had obſerved it on the 9th of Auguſt to be of the ſecond magnitude, and on the 3d of September the ſame year it was of the third magnitude. Mr Pigot deduced its period from its apparent equality with a ſmall ſtar in the neighbourhood, and thence found it to be 320, 328, and 337 days.

49 Algol.

The moſt remarkable of theſe changeable ſtars is that called *Algol*, in the head of Meduſa. It had long been known to be variable; but its period was firſt aſcertained by Mr Goodricke of York, who began to obſerve it in the beginning of 1783. It changes continually from the firſt to the fourth magnitude; and the time taken up from its greateſt diminution to its leaſt is found, at a mean, to be 2 days 20 hours 49 minutes and 3 ſeconds. During four hours it gradually diminiſhes in luſtre, which it recovers during the ſucceeding four hours; and in the remaining part of the period it invariably preſerves its greateſt luſtre, and after the expiration of the term its diminution again commences. According to Mr Pigot, the degree of brightneſs of this ſtar when at its *minimum* is variable in different periods, and he is of the ſame opinion with regard to its brightneſs when at its full; but whether theſe differences return regularly or not, has not been determined.

The 420th of Mayer's catalogue in Leo, has lately been ſhewn to be variable by Mr. Koch. Some years before 1782, that gentleman perceived it undoubtedly ſmaller than the 419th of the ſame catalogue. In February

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bruary that year, it was of the ſame brightneſs with the 419th, that is, of the ſeventh magnitude. In April 1783, it was of the ninth magnitude; and in the ſame month 1784, it was of the tenth. Mr Pigot could never obſerve this ſtar, though he frequently looked for it with a night-glaſs, and on the fifth of April 1785 with a three-feet achromatic tranſit inſtrument.

50 Variable ſtar in Hydra.

In 1704, Maraldi obſerved a variable ſtar in Hydra, whoſe period he ſettled at about two years, though with conſiderable variations: but from the obſervations even of Maraldi, Mr Pigot concludes, that its period was then only 494 days; and from ſome others made by himſelf, he thinks that now it is only 487 days; ſo that ſince the time of Maraldi it has ſhortened ſeven days. The particulars relating to this ſtar are as follow. 1. When at its full brightneſs it is of the fourth magnitude, and does not perceptibly change for a fortnight. 2. It is about ſix months in increaſing from the tenth magnitude and returning to the ſame; ſo that it may be conſidered as inviſible during that time. 3. It is conſiderably more quick, perhaps one half more ſo, in its increaſe than in its decreaſe. 4. Though when at its full it may always be ſtyled a ſtar of the fourth magnitude, it does not conſtantly attain the ſame degree of brightneſs, but the differences are very ſmall. This ſtar is the 30th of Hydra in Hevelius's catalogue, and is marked by him of the ſixth magnitude.

51 Swan's head.

The new ſtar in Serpentarius, obſerved by Kepler, ſeems to have been of the ſame nature with that of Caſſiopeia; and Mr. Pigot therefore looks upon it alſo to be a periodical one, though, after taking a plan of the neareſt ſtars in that part of the heavens, in the year 1782, he could, in four years time, perceive no alteration.

The variation of the ſtar β Lyræ was diſcovered by Mr Goodricke abovementioned, who ſuſpects its period to be ſix days nine hours; which coincides with the opinion of Mr Pigot.

The new ſtar near the Swan's Head, obſerved by Don Anthelme in December 1669, ſoon became of the third magnitude, and diſappeared in 1672. Mr Pigot has conſtantly looked for it ſince November 1781, but without ſucceſs. He is of opinion, that had it only increaſed to the 10th or 11th magnitude, he would have ſeen it, having taken a plan of all the neighbouring ſmall ſtars.

The next variable ſtar in Mr Pigot's catalogue is the η Antinoi, whoſe variation and period he diſcovered in 1785. From his corrected obſervations, he concludes that it continues at its greateſt brightneſs 40 hours without decreaſing; it is 66 hours after it begins to decreaſe before it comes to its full diminution; after which it continues ſtationary for 30 hours more, and then increaſes for 36 hours. In every period it ſeems to acquire its full brightneſs, and to be equally decreaſed.

52 Swan's neck.

The variable ſtar in the Swan's Neck was obſerved for three years. The period of this ſtar had been ſettled by Maraldi and Caſſini at 405, and by M. Le Gentil at 405.3 days; but from a mean of the obſervations of Mr Pigot, it appears to be only 329. "Perhaps (ſays he) its period is irregular; to determine which ſeveral intervals of 15 years ought to be taken; and I am much inclined to believe that it will be found only 396 days 21 hours." The particulars relating to this ſtar are: 1. When at its full brightneſs it undergoes no perceptible change for a fortnight. 2. It is about three months and an half in increaſing from the 11th magnitude to its full brightneſs, and the ſame in decreaſing; for which reaſon it may be conſidered as inviſible during ſix months. 3. It does not always attain the ſame degree of luſtre, being ſometimes of the fifth and ſometimes of the ſeventh magnitude.

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53 Swan's breaſt.

In 1600, G. Janſonius diſcovered a variable ſtar in the breaſt of the Swan, which was afterwards obſerved by different aſtronomers, and ſuppoſed to have a period of about ten years. The reſults of Mr Pigot's calculations from the obſervations of former aſtronomers are, 1. That it continues in full luſtre for five years. 2. It decreaſes rapidly for two years. 3. It is inviſible to the naked eye for four years. 4. It increaſes ſlowly during ſeven years. 5. All theſe changes are completed in 18 years. 6. It was at its *minimum* at the end of the year 1663. 7. It does not always increaſe to the ſame degree of brightneſs, being ſometimes of the third, and at others only of the ſixth magnitude. "I am entirely ignorant (ſays Mr. Pigot) whether it is ſubject to the ſame changes in this century, having not met with any ſeries of obſervations on it; but if the above conjectures are right, it will be at its minimum in a very few years. Since November 1781 I have conſtantly ſeen it of the ſixth magnitude. Sometimes I have ſuſpected that it has decreaſed within theſe two laſt years, though in a very ſmall degree."

The laſt ſtar in Mr. Pigot's firſt claſs is the δ Cephei, whoſe variation was diſcovered by Mr. Goodricke. Its changes are very difficult to be ſeen, unleſs it is obſerved at the times of its greateſt and leaſt brightneſs. The reſult of the obſervations hitherto made upon it are, that its period conſiſts of 5 days 8 hours 37′ on a mean. The following obſervations relate to ſome ſtars of the ſecond claſs.

54 Stars, the variation of which is leſs certain.

1. Hevelius's 6th Caſſiopeæ was miſſing in 1782, nor could Mr Pigot find it in 1783 and 1784.

2. ξ or 46th Andromedæ, ſaid to be variable, but the evidence is not convincing to Mr Pigot.

3. Flamſtead's 50, 52, Andromedæ, and Hevelius's 41 Andromedæ. The poſition and characters of theſe ſtars differ conſiderably in different catalogues, and ſome of them are ſaid by Caſſini to have diſappeared and reappeared. Mr Pigot therefore gives their comparative brightneſs as obſerved in the years 1783, 1784, and 1785, during which time he does not mention any particular change.

4. Tycho's 20th Cœti. "This (ſays Mr Pigot) muſt be the ſtar which Hevelius ſaid had diſappeared, being Tycho's ſecond in the Whale's Belly. There can hardly be any doubt that it is the χ, miſplaced by Tycho. This χ is of the fourth or fifth magnitude."

5. σ, or the 17th Eridani of Ptolemy and Ulug Beigh. Flamſtead ſays he could not ſee this ſtar in 1691 and 1692; but in 1782, 1783, and 1784, Mr Pigot obſerved in that place one of the ſeventh magnitude, which appeared always of the ſame luſtre.

6. Flamſtead's 41 Tauri was ſuppoſed by Caſſini to be either a new or variable ſtar; but Mr Pigot thinks there is no reaſon to be of that opinion. "That it is

not

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not new (says he) is evident, since it is Ulug Beigh's 26th and Tycho's 43d.

7. A star about 2½ north of 53 Eridani, and 47 Eridani. Cassini supposed the first of these stars to be a new one, and that it was not visible in 1664. He mentions another star thereabouts, which he also esteemed a new one.

8. γ Canis Majoris. Maraldi could not see this star in 1670; but in 1692 and 1693 it appeared of the fourth magnitude. Mr Pigot made frequent observations upon it from 1782 to 1786, but could perceive no variation.

9. α, β Geminorum. "If either of these stars (says our author) have changed in brightness, it is probable the β. In 1783, 1784, and 1785, the β was undoubtedly brighter than α."

10. ξ Leonis. According to Montanari, this star was hardly visible in 1693. In 1783, 1784, and 1785, it was of the fifth magnitude. By Tycho, Flamstead, Mayer, Bradley, &c. it is marked of the fourth.

11. 4 Leonis. This star is said to have disappeared before the year 1667, but according to Mr Pigot's observations, was constantly of the fifth or sixth magnitude since 1783.

12. 25th Leonis. In 1783 our author first perceived that this star was missing, and could not perceive it in 1784 and 1785, even with a transit instrument.

13. Bayer's *i* Leonis, or Tycho's 16 Leonis, was not visible in 1709, nor could it be seen in 1785. It is a different star from the *i* Leonis of the other catalogues, though Tycho's description of its place is the same.

14. δ Ursæ Majoris. This star is suspected to change in brightness, on account of its being marked by Tycho, the prince of Hesse, &c. of the second magnitude, while Hevelius, Bradley and others have marked it of the third. In 1786, and for three years before it appeared as a bright star of the fourth magnitude.

15. η Virginis. This is supposed to be variable, because Flamstead, on the 27th of January 1680, could not see it; but he observed it in 1677, and some years afterwards. Mr Pigot observed it frequently in 1784 and 1785, and found it a star of the sixth magnitude without any perceptible change.

16. Bayer's star of the sixth magnitude 1° south of *g* Virginis. "This star (says Mr Pigot) is not in any of the nine catalogues that I have. Maraldi looked for it in vain; and in May 1785 I could not see the least appearance of it. It certainly was not of the eighth magnitude."

17. A star in the northern thigh of Virgo, marked by Ricciolus of the sixth magnitude, could not be seen by Maraldi in 1709: nor was it of the ninth magnitude, if at all visible in 1785.

18. The 91 and 92 Virginis. In 1785, one of these stars, probably the 91, was missing; the remaining one is of the sixth or seventh magnitude.

19. α Draconis. Mr Pigot coincides in opinion with Mr Herschel, that this star is variable. Bradley, Flamstead, &c. mark it of the second magnitude, but in 1786 it was only a bright fourth. It was frequently examined by Mr Pigot from the 4th of October 1782, but without any alteration being perceived.

20. Bayer's star in the west scale of Libra. Maraldi could not see this star, and it was likewise invisible to Mr Pigot in 1784 and 1785.

21. N° 6 of Ptolemy and Ulug Beigh's unformed in Libra. This star is not mentioned in any other catalogues than the above. Mr Pigot frequently observed a little star of the seventh magnitude very near its place.

22. ι Libræ. This star is thought to be variable; but Mr Pigot is not of that opinion, though "certainly (says he) it is rather singular, that Hevelius, whose attention was directed to that part of the heavens to find Tycho's 11th, did not find the ι; and the more so, as he has noticed two much smaller stars not far from it. During these three years I have found the ι constantly of the fifth magnitude."

23. Tycho's 11th Libræ. Mr Pigot is of opinion that no such star as this ever existed; and that it is no other than the ι with an error of 2 degrees of longitude.

24. 33 Serpentis. This star was missing in 1784; nor could it be perceived with a night-glass in 1785.

25. A star marked by Bayer near ι Ursæ majoris. This star could not be seen by Cassini; nor was Mr Pigot able to discover it with a night-glass in 1782.

26. The ρ, or Ptolemy and Ulug Beigh's 14th Ophiuchi, or Flamstead's 36th. Mr Pigot has no doubt that this is the star which is said to have disappeared before the year 1695; and it is evident that it was not seen by Hevelius. In 1784 and 1785 Mr Pigot found it of the fourth or fifth magnitude: but he is far from being certain of its having undergone any change, especially as it has a southern declination of 26 degrees; for which reason great attention must be paid to the state of the atmosphere.

27. Ptolemy's 13th and 18th Ophiuchi, fourth magnitude. Mr Pigot is of opinion that these stars are misplaced in the catalogues. The 18th of Ptolemy he thinks ought to be marked with a north latitude instead of a south, which would make it agree nearly with Flamstead's 58th; and he is also of opinion that the 13th of Ptolemy is the 40th of Flamstead.

28. σ Sagittarii. Mr Herschel, as well as Mr Pigot, is of opinion, that this star has probably changed its magnitude, though the reason seems only to be the great disagreement concerning it among the different catalogues of stars.

29. θ Serpentis. This star, according to Mr Montanari, is of variable magnitude; but Mr Pigot never could perceive any alteration.

30. Tycho's 27th Capricorni was missing in Hevelius's time, and Mr Pigot could not find it with a transit instrument.

31. Tycho's 22d Andromedæ, and ο Andromedæ. Mr Cassini informs us, that in his time the former had grown so small that it could scarcely be seen; and Mr Pigot, that no star was to be seen its place in 1784 and 1785: but he is of opinion that Cassini may have mistaken the ο Andromedæ for the 22d; for which reason he observed this star three years, but without any alteration in its brightness.

32. Tycho's 19th Aquarii. Hevelius says that this star was missing, and that Flamstead could not see it with his naked eye in 1679. Mr Pigot could not see it in 1782; but is persuaded that it is the same with

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Flamſtead's 56th marked *f* by Bayer, from which it is only a degree and an half diſtant. The 53d of Flamſtead, marked *f* in Ptolemy's catalogue, is a diſferent ſtar.

33. La Caille's 483 Aquarii was firſt diſcovered to be miſſing in 1778, and was not viſible in 1783 and 1784.

Beſides theſe there are ſeveral others certainly variable, but which cannot be ſeen in this country. There are ſome alſo ſuſpected to be variable, but for which Mr Pigot thinks there is no reaſon. Mr Herſchel alſo gives ſtrong reaſons for not laying great ſtreſs on all the obſervations by which new ſtars have been ſaid to be diſcovered. Mr Pigot aſſures us from repeated experience, that even more than a ſingle obſervation, if not particulariſed and compared with neighbouring ſtars, is very little to be depended upon; different ſtreaks of the clouds, the ſtate of the weather, &c. having often cauſed him to err a whole magnitude in the brightneſs of the ſtar.

35 Wollaſton's method of diſcovering variations among the fixed ſtars.

As theſe changes to which the fixed ſtars are liable do not ſeem to be ſubject to any certain rule, Mr Wollaſton has given an eaſy method of obſerving whether they do take place in any part of the heavens or not, and that without much expence of inſtruments or waſte of time, which are great objections to aſtronomical obſervations in general. His firſt idea was, that the work ſhould be undertaken by aſtronomers in general; each taking a particular diſtrict of the heavens, and from time to time obſerving the right aſcenſion and declination of every ſtar in that ſpace allotted to him, framing an exact map of it, and communicating their obſervations to one common place of information. This method, however, being too laborious, he next propoſes the noting down at the time, or making a drawing of what one ſees while they are obſerving. A drawing of this kind once made, would remain, and could be conſulted on any future occaſion; and if done at firſt with care, a tranſient review would diſcover whether any ſenſible change had taken place ſince it was laſt examined, which could not ſo well be done by catalogues or verbal deſcription. For this purpoſe he recommends the following method: "To a night-glaſs, but of Dollond's conſtruction, which magnifies about ſix times, and takes in about as many degrees of a great circle, I have added croſs wires interſecting one another at an angle of 45 degrees. More wires may be croſſed in other directions; but I apprehend theſe will be ſufficient. This teleſcope I mount on a polar axis. One coarſely made, and without any diviſions on its circle of declination, will anſwer the purpoſe, as there is no great occaſion for accuracy in that reſpect; but as the heavenly bodies are more readily followed by an equatorial motion of the teleſcope, ſo their relative poſitions are much more eaſily diſcerned when they are looked at conſtantly as in the ſame direction. An horizontal motion, except in the meridian, would be apt to miſlead the judgment. It is ſcarcely neceſſary to add, that the wires muſt ſtand ſo as for one to deſcribe a parrallel of the equator nearly; another will then be a horary circle, and the whole area will be divided into eight equal ſectors.

"Thus prepared, the teleſcope is to be pointed to a known ſtar, which is to be brought into the centre or common interſection of all the wires. The relative poſitions of ſuch other ſtars as appear within the field are to be judged of by the eye; whether at $\frac{1}{4}$, $\frac{1}{3}$, or $\frac{1}{2}$ from the centre towards the circumference, or *vice verſa*; and ſo with regard to the neareſt wire reſpectively. Theſe, as one ſees them, are to be noted down with a black-lead pencil upon a large meſſage-card held in the hand, upon which a circle ſimilarly divided is ready drawn. One of three inches diameter ſeems moſt convenient. The motion of the heavenly bodies in ſuch a teleſcope is ſo ſlow, and the noting down of the ſtars ſo quickly done, that there is commonly full time for it without moving the teleſcope. When that is wanted, the principal ſtar is eaſily brought back again into the centre of the field at pleaſure, and the work reſumed. After a little practice, it is aſtoniſhing how near one can come to the truth in this way: and tho' neither the right aſcenſions nor the declinations are laid down by it, nor the diſtances between the ſtars meaſured; yet their apparent ſituations being preſerved in black and white, with the day and year, and hour, if thought neceſſary, written underneath, each card then becomes a regiſter of the then appearance of the heavens; which is eaſily re-examined at any time with little more than a tranſient view; and which will yet ſhow, on the firſt glance, if there ſhould have happened in it any alteration of conſequence."

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Fig. 35. ſhows part of the corona borealis delineated in this manner, and which was afterwards fully taken down by making the ſtars α, β, γ, δ, ϵ, ζ, ϑ, ι, $\varkappa$, π, ρ, σ, and τ ſucceſſively central; and theſe were joined with ſome of the ſtars of Bootes, for the ſake of connecting the whole, and united into one map, as repreſented fig. 37. Plate LXVI.

In obſerving in this way, it is evident, that the places of ſuch ſtars as happen to be under or very near any of the wires are more to be depended upon than thoſe which are in the intermediate ſpaces, eſpecially if towards the edges of the fields; ſo alſo thoſe which are neareſt to the centre, becauſe better defined, and more within the reach of one wire or another. For this reaſon, different ſtars of the ſame ſet muſt ſucceſſively be made central, or brought towards one of the wires, where any ſuſpicion ariſes of a miſtake, in order to approach nearer to a certainty; but if the ſtand of the teleſcope be tolerably well adjuſted and fixed, this is ſoon done.

In ſuch a glaſs it is ſeldom that light ſufficient for diſcerning the wires is wanting. When an illuminator is required, a piece of card or white paſteboard projecting on one ſide beyond the tube, and which may be brought forward occaſionally, is better than any other. By cutting acroſs a ſmall ſegment of the object-glaſs, it throws a ſufficient light down the tube though the candle be at a great diſtance, and one may loſe ſight of the falſe glare by drawing back the head, and moving the eye a little to one ſide, when the ſmall ſtars will be ſeen as if no illuminator was there. See a delineation of the principal fixed ſtars, with the apparent path of the ſun among them, on plate LXIV. and LXV.

36 Galaxy, or milky-way.

A very remarkable appearance in the heavens is that called the *galaxy*, or *milky-way*. This is a broad circle, in ſome places double, but for the moſt part ſingle, ſurrounding the whole celeſtial concave. It is of a whitiſh colour, ſomewhat reſembling a faint aurora borealis; but Mr Brydone, in his journey to the top of mount Ætna, found that phenomenon to make a glorious appearance

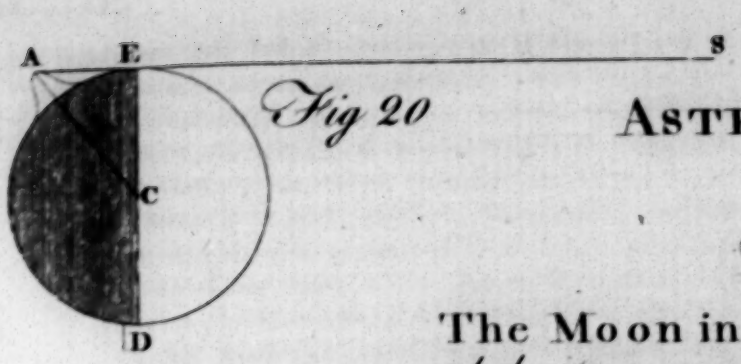

Fig 20

ASTRONOMY

Fig 21
1773 h. 8. 55
2 S. at
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Fig 19
The Moon in her mean libration
with the Spots according to Riccioli Cassini &c

Fig 22

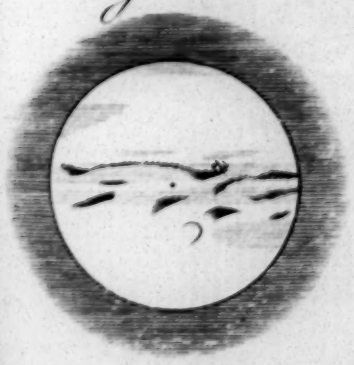

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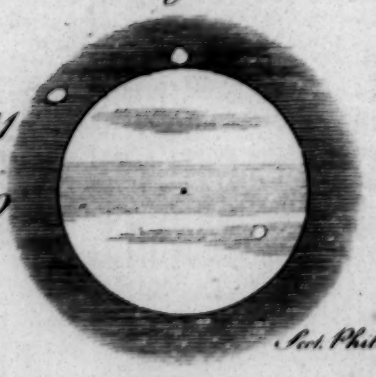
Fig 23

Nov.r 13 1773

Fig 22



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Sect. Philad.a

BRITISH MUSEUM

Appearances of Celestial Bodies thro' Telescopes.

pearance, being, as he expresses it, like a pure flame that shot across the heavens.

The only appearance, besides those already mentioned, which are very observable by the unassisted eye, are those unexpected obscurations of the sun and moon, commonly called *eclipses*. These are too well known, and attract the attention too much, to need any particular description. We have, however, accounts very well authenticated, of obscurations of the sun continuing for a much longer time than a common eclipse possibly can do, and likewise of the darkness being much greater than it usually is on such occasions: and that these accounts are probably true, we shall afterwards have occasion to observe.

57 Eclipses.

Sect. II. *Of the Appearances of the Celestial Bodies as seen through Telescopes.*

1. The sun, tho' to human eyes so extremely bright and splendid, is yet frequently observed, even through a telescope of but very small powers, to have dark spots on his surface. These were entirely unknown before the invention of telescopes, though they are sometimes of sufficient magnitude to be discerned by the naked eye, only looking through a smoked glass to prevent the brightness of the luminary from destroying the sight. The spots are said to have been first discovered in the year 1611; and the honour of the discovery is disputed betwixt Galileo and Scheiner, a German Jesuit at Ingoldstadt. But whatever merit Scheiner might have in the priority of the discovery, it is certain that Galileo far exceeded him in accuracy, though the work of Scheiner has considerable merit, as containing observations selected from above 3000, made by himself. Since his time the subject has been carefully studied by all the astronomers in Europe; the result of whose observations, as given by Dr Long, is to the following purpose.

58 Solar spots when first discovered.

59 Dr Long's account of them.

There is great variety in the magnitudes of the solar spots; the difference is chiefly in superficial extent of length and breadth; their depth or thickness is very small: some have been so large, as by computation to be capable of covering the continents of Asia and Africa; nay, the whole surface of the earth, or even five times its surface. The diameter of a spot, when near the middle of the disk, is measured by comparing the time it takes in passing over a cross hair in a telescope, with the time wherein the whole disk of the sun passes over the same hair; it may also be measured by the micrometer; and by either of these methods we may judge how many times the diameter of the spot is contained in the diameter of the sun. Spots are subject to increase and diminution of magnitude, and seldom continue long in the same state. They are of various shapes; most of them having a deep black nucleus surrounded by a dusky cloud, whereof the inner parts near the black are a little brighter than the outskirts. They change their shapes, something in the manner that our clouds do; though not often so suddenly: thus, what is of a certain figure to-day, shall, to-morrow, or perhaps in a few hours, be of a different one; what is now but one spot, shall in a little time be broken into two or three; and sometimes two or three spots shall coalesce, and be united into one. Dr Long, many years since, while he was viewing the image of the sun through a telescope cast upon white paper, saw one roundish spot, by estimation not much less than the diameter of our earth, break into two, which receded from one another with prodigious velocity. This observation was singular at the time; for though several writers had taken notice of this after it was done, none of them had been making any observation at the time it was actually doing.

Appearances of Celestial Bodies thro' Telescopes.

The number of spots on the sun is very uncertain; sometimes there are a great many, sometimes very few; and sometimes none at all. Scheiner made observations on the sun from 1611 to 1629; and says he never found his disk quite free of spots, excepting a few days in December 1624. At other times he frequently saw 20, 30, and in the year 1625 he was able to count 50 spots on the sun at a time. In an interval afterwards of 20 years, from 1650 to 1670, scarce any spots were to be seen, and since that time some years have furnished a great number of spots, and others none at all; but since the beginning of the last century, not a year passed wherein some were not seen; and at present, says Mr Cassini, in his *Elemens d' Astronomie* published in 1740, they are so frequent, that the sun is seldom without spots, and often shows a good number of them at a time.

From these phenomena, it is evident, that the spots are not endowed with any permanency, nor are they at all regular in their shape, magnitude, number, or in the time of their appearance or continuance. Hevelius observed one that arose and vanished in 16 or 17 hours; nor has any been observed to continue longer than 70 days, which was the duration of one in the year 1676: those spots that are formed gradually, are gradually dissolved; while those that arise suddenly, are for the most part suddenly dissolved. When a spot disappears, that part where it was generally becomes brighter than the rest of the sun, and continues so for several days; on the other hand, those bright parts (called *faculæ*, as the others are called *maculæ*) sometimes turn to spots.

60 The solar spots move from west to east.

The solar spots appear to have a motion which carries them across the sun's disk. Every spot, if it continues long enough without being dissolved, appears to enter the sun's disk on the east side, to go from thence with a velocity continually increasing till it has gone half its way; and then to move slower and slower, till it goes off at the west side, after which it disappears for about the same space of time that it spent in crossing the disk, and then enters upon the east side again, nearly in the same place, and crosses it in the same tract, and with the same unequal motion as before. This apparent inequality in the motion of the spots is purely optical, and is in such proportion as demonstrates them to be carried round equably or in a circle, the plane of which continued passes through or near the eye of a spectator upon the earth.

Besides the real changes of the spots already mentioned, there is another which is purely optical, and is owing to their being seen on a globe differently turned towards us. If we imagine the globe of the sun to have a number of circles drawn upon its surface, all passing through the poles, and cutting his equator at equal distances, these circles which we may call meridians, if they were visible, would appear to us at unequal distances, as in fig. 2. Now, suppose a spot were round, and so large as to reach from one meridian to another, it would appear round only at *g*, when it was in the middle of that half of the globe which is to-

Plate LX.

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wards our earth; for then we view the full extent of it in length and breadth: in every other place it turns away from us, and appears narrower, though of the same length, the farther it is from the middle; and on its coming on at *a*, and going off at *n*, it appears as small as a thread, the thin edge being then all that we see.

The motion of the spots is in the order of the signs (the same way that all motions in the solar system, those of the comets alone excepted, are performed); and therefore, as the earth revolves round the sun the same way with the solar spots, one of these will appear to remain longer on the disk than it would otherwise do if the earth remained at rest. Thus, in fig. 3. let A B C D be the orbit of the earth, *a b c d* the equator of the sun; let *a* be a spot seen in the middle of the disk by a spectator upon the earth at A. The spot being carried round through *b c d*, according to the order of the letters, will in about 25 days bring it again to *a*: but during that interval, the earth will be got to B, and the middle of the disk at *b*; so that about two days more will intervene before a spectator upon the earth at C will view it in the middle of the then apparent disk at *c*. There are, however, but few instances of such returning spots; so that Scheiner, out of his multitude of observations, found only three or four of this kind.

Plate LX.

As fig. 2. is an orthographic projection of meridians on the sun's disk, it may be thought that they would show the apparent diurnal motion of the spots; so that, for example, a spot which to-day at noon is in the meridian marked *a*, would to-morrow at noon be in that marked *b*, the next day in that marked *c*, and so on: but Scheiner says, that, casting the sun's picture on paper through a telescope, the distance between the place of a spot at noon any given day and the place at noon the day immediately preceding, or the day immediately following, will be greater when the spot is near the circumference of the disk than according to the orthographic projection it ought to be. This deviation of spots he thought owing to the refraction of the glasses in the telescope being greater near the circumference than in the middle; and he was confirmed in this opinion, by finding, that if spots were observed by letting the sun shine through a small hole without a glass, upon white paper held at a good distance from the hole in a dark room, their places would then be every day according to the orthographic projection. But he found this method of observing the solar spots attended with great difficulties. Another proof that this deviation of the solar spots is occasioned by the different refraction of the glasses of the telescope, is deduced from the following experiment. Our author pierced with a needle 12 small holes at equal distances in a thin plate of brass; and placing the plate before the glasses of a short telescope, let the sun shine through, receiving 12 bright spots upon a white paper placed in such a manner that the light might fall perpendicularly upon it. Here also he found the distances between the spots near the outside greater than between those in the middle; whereas, when he received them upon paper without any glasses, the situation of the bright spots exactly corresponded to that of the small holes in the plate.

The face of the sun, when clear of spots, seen by the naked eye through a smoked or coloured glass, or through a thin cloud, or the vapours near the horizon, appears all over equally luminous: but when viewed thro' the telescope, the glasses being smoked or coloured, besides the difference between the faculæ and the other parts, the middle of the disk appears brighter than the outskirts; because the light is darted more directly towards us from the middle than from any other part, and the faculæ appear more distinctly near the sides, as being on a darker ground than in the middle.

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61

Account of their phenomena by different observers.

The phenomena of the solar spots, as delivered by Scheiner and Hevelius, may be summed up in the following particulars. 1. Every spot which hath a nucleus, or considerably dark part, hath also an umbra, or fainter shade, surrounding it. 2. The boundary betwixt the nucleus and umbra is always distinct and well defined. 3. The increase of a spot is gradual, the breadth of the nucleus and umbra dilating at the same time. 4. In like manner, the decrease of a spot is gradual, the breadth of the nucleus and umbra contracting at the same time. 5. The exterior boundary of the umbra never consists of sharp angles; but is always curvilinear, how irregular soever the outline of the nucleus may be. 6. The nucleus of a spot, whilst on the decrease, often changes its figure by the umbræ encroaching irregularly upon it, insomuch that in a small space of time new encroachments are discernible, whereby the boundary betwixt the nucleus and umbra is perpetually varying. 7. It often happens, by these encroachments, that the nucleus of a spot is divided into two or more nuclei. 8. The nuclei of the spots vanish sooner than the umbra. 9. Small umbræ are often seen without nuclei. 10. An umbra of any considerable size is seldom seen without a nucleus in the middle of it. 11. When a spot which consisted of a nucleus and umbra is about to disappear, if it is not succeeded by a *facula*, or spot brighter than the rest of the disk, the place where it was is soon after not distinguished from the rest.

In the Philosophical Transactions, Vol. LXIV. Dr Wilson, professor of astronomy at Glasgow, hath given a dissertation on the nature of the solar spots, and mentions the following appearances. 1. When the spot is about to disappear on the western edge of the sun's limb, the eastern part of the umbra first contracts, then vanishes, the nucleus and western part of the umbra remaining; then the nucleus gradually contracts and vanishes, while the western part of the umbra remains. At last this disappears also; and if the spot remains long enough to become again visible, the eastern part of the umbra first becomes visible, then the nucleus; and when the spot approaches the middle of the disk, the nucleus appears environed by the umbra on all sides, as already mentioned. 2. When two spots lie very near to one another, the umbra is deficient on that side which lies next the other spot: and this will be the case, though a large spot should be contiguous to one much smaller; the umbra of the large spot will be totally wanting on that side next the small one. If there are little spots on each side of the large one, the umbra does not totally vanish; but appears flattened, or pressed in towards the nucleus on each side. When the little spots disappear, the umbra of the large one extends itself as usual. This circumstance, he observes, may sometimes prevent the disappearance of the umbra in the manner

above-

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abovementioned; so that the western umbra may disappear before the nucleus, if a small spot happens to break out on that side.

In the same volume, p. 337. Mr Wollaston observes, that the appearances mentioned by Dr Wilson are not constant. He positively affirms, that the faculæ or bright spots on the sun are often converted into dark ones. "I have many times (says he) observed, near the eastern limb, a bright facula just come on, which has the next day shown itself as a spot, though I do not recollect to have seen such a facula near the western one after a spot's disappearance. Yet, I believe, both these circumstances have been observed by others; and perhaps not only near the limbs. The circumstance of the faculæ being converted into spots I think I may be sure of. That there is generally (perhaps always) a mottled appearance over the face of the sun, when carefully attended to, I think I may be as certain. It is most visible towards the limbs, but I have undoubtedly seen it in the centre; yet I do not recollect to have observed this appearance, or indeed any spots towards his poles. Once I saw with a twelve-inch reflector, a spot burst to pieces while I was looking at it. I could not expect such an event, and therefore cannot be certain of the exact particulars; but the appearance, as it struck me at the time, was like that of a piece of ice when dashed on a frozen pond, which breaks to pieces and slides in various directions." He also acquaints us, that the nuclei of the spots are not always in the middle of the umbræ; and gives the figure of one seen November 13th 1773, which is a remarkable instance to the contrary. Mr Dunn, however, in his new Atlas of the Mundane System, gives some particulars very different from the above. "The face of the sun (says he) has frequently many large black spots, of various forms and dimensions, which move from east to west, and round the sun, according to some observations in 25 days, according to others in 26, and according to some in 27 days. The black or central part of each spot is in the middle of a great number of very small ones, which permit the light to pass between them. The small spots are scarce ever in contact with the central ones: but what is most remarkable when the whole spot is near the limb of the sun, the surrounding small ones form nearly a straight line, and the central part projects a little over it, like Saturn in his ring."

62 Mr Dunn's account.

The spots are by no means confined to one part of the sun's disk; though we have not heard of any being observed about his polar regions; and though their direction is from east to west, yet the paths they describe in their course over the disk are exceedingly different; sometimes being straight lines, sometimes curves, sometimes descending from the northern to the southern part of the disk, sometimes ascending from the southern to the northern, &c. This was observed by Mr Derham (Philos. Trans. N° 330), who hath given figures of the apparent paths of many different spots, wherein the months in which they appeared, and their particular progress each day, are marked.

63 Mercury and Venus sometimes appear as spots.

Besides these spots, there are others which sometimes appear very round and black, travelling over the disk of the sun in a few hours. They are totally unlike the others, and will be shown to proceed from an interposition of the planets Mercury and Venus between the earth and the sun. Excepting the two kinds of spots abovementioned, however, no kind of object is discovered on the surface of the sun, but he appears like an immense ocean of elementary fire or light.

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2. With the moon the case is very different. Many darkish spots appear in her to the naked eye; and, through a telescope, their number is prodigiously increased: she also appears very plainly to be more protuberant in the middle than at the edges, or to have the figure of a globe, and not a flat circle. When the moon is horned or gibbous, the one side appears very ragged and uneven, but the other always exactly defined and circular. The spots in the moon always keep their places exactly; never vanishing, or going from one side to the other, as those of the sun do. We sometimes see more or less of the northern and southern, and eastern and western part of the disk or face; but this is owing to what is called her libration, and will hereafter be explained.

63 Telescopic view of the moon.

The astronomers Florentius, Langrenus, John Hevelius of Dantzick, Grimaldus, Ricciolus, Cassini, and M. de la Hire, have drawn the face of the moon as she is seen through telescopes magnifying between 200 and 300 times. Particular care has been taken to note all the shining parts in her surface; and, for the better distinguishing them, each has been marked with a proper name. Langrenus and Ricciolus have divided the lunar regions among the philosophers, astronomers, and other eminent men; but Hevelius and others, fearing lest the philosophers should quarrel about the division of their lands, have endeavoured to spoil them of their property, by giving the names belonging to different countries, islands, and seas on earth, to different parts of the moon's surface, without regard to situation or figure. The names adopted by Riccioli, however, are those which are generally followed, as the names of *Hipparchus Tycho, Copernicus*, &c. are more pleasing to astronomers than those of Africa, the Mediterranean Sea, Sicily, and Mount Ætna. On Plate LXIII. is a tolerably exact representation of the full moon in her mean libration, with the numbers to the principal spots according to Riccioli, Cassini, Mayer, &c. The asterisk refers to one of the volcanoes discovered by Dr Herschel, to be afterwards more particularly noticed. The names are as follow:

* Herschel's Volcano.
1 Grimaldus.
2 Galileus.
3 Aristarchus.
4 Keplerus.
5 Gassendus
6 Shikardus.
7 Harpalus.
8 Heraclides.
9 Lansbergius.
10 Reinoldus.
11 Copernicus
12 Helicon.
13 Capuanus.
14 Bullialdus.
15 Eratosthenes.
16 Timocharis.
17 Plato.
18 Archimedes.
19 Insula Sinus Medii.
20 Pitatus.
21 Tycho.
22 Eudoxus.
23 Aristoteles.
24 Manilius.
25 Menelaus.
26 Hermes.
27 Possidonius.
28 Dionysius.
29 Plinius.
30 Calharina Cyrillus. Theophilus.
31 Fracastorius.
32 Promontorium acutum Censorinus.
33 Messala.
34 Promontorium somnii.
35 Proclus.
36 Cleomedes.
37 Snellius et Furnerius.
38 Petavius.

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38 Petavius.
39 Langrenus
40 Taruntius.
A Mare Humorum.
B Mare Nubium.
C Mare Imbrium.
D Mare Nectaris.
E Mare Tranquilitatis.
F Mare Serenitatis.
G Mare Fœcunditatis.
H Mare Crisium.

We have already observed, that when the planet Mars approaches any of the fixed stars, they lose their light, and sometimes totally disappear before he seems to touch them: but it is not so with the moon; for though she very often comes in betwixt us and the stars, they preserve their lustre till immediately in seeming contact with her, when they suddenly disappear, and as suddenly re-appear on the opposite side. When Saturn, however, was hid by the moon in June 1762, Mr. Dunn, who watched his appearance at the emersion, observed a kind of faint shadow to follow him for a little from the edge of the moon's disk. This appearance is represented fig. 88. Plate LXIX.

64 Mercury appears always equally luminous.

3. Mercury, when looked at through telescopes magnifying about 200 or 300 times, appears equally luminous throughout his whole surface, without the least dark spot. He appears indeed to have the same difference of phases with the moon, being sometimes horned, sometimes gibbous, and sometimes shining almost with a round face, though not entirely full, because his enlightened side is never turned directly towards us, unless when so near the sun as to be invisible; but at all times perfectly well defined without any ragged edge, and perfectly bright.

65 Spots, when first discovered on the disk of Venus.

4. Dr Long informs us, that the earliest account he had met with of any spots seen by means of the telescope on the disk of Venus was in a collection of letters printed at Paris in 1665, in one of which M. Auzout relates his having received advice from Poland that Mr Burratini had, by means of large telescopes, seen spots upon the planet Venus similar to those upon the moon. In 1667, Cassini, in a letter to Mr Pettit, mentions his having for a long time carefully observed Venus through an excellent telescope made by Campani, in order to know whether that planet revolved on its axis or not, as he had before found Jupiter and Mars to do. But though he then observed some spots upon her, he says, that even when the air was quiet and clear, they appeared faint, irregular, and not well defined: so that it was difficult to have such a distinct view of any of them as to be certain that it was the same spot which was seen again in any subsequent observation; and this difficulty was increased, in the first place, when Venus was in her inferior semicircle; because at that time she must be viewed through the thick vapours near the horizon; though otherwise it was most proper, on account of her being then nearest to us. In the second place, if we would observe her at some height above those vapours, it could only be for a short time; and, thirdly, when she is low in her inferior circle, and at that time nearest the earth, the enlightened part of her is too small to discover any motion in it. He was therefore of opinion, that he should succeed better in his observations when the planet was about its mean distance from us, showing about one-half of her enlightened hemisphere; at which time also he could observe her for a much longer time above the gross atmospherical vapours. His first appearance of success was October 14. 1666 at three-quarters past five in the evening; when he saw a bright spot (fig. 37.), but could not then view that spot long enough to draw any inference concerning the planet's motion. He had no farther success till the 20th of April, the following year; when, about a quarter of an hour before sunrise, he began again to perceive on the disk of Venus, now about half enlightened, a bright part near the section, distant from the southern horn a little more than a fourth-part of the diameter of the disk, and near the eastern edge. He took notice also of a darkish oblong spot nearer to the northern than the southern horn: at sunrise the bright part was advanced further from the southern horn than when he first observed it; but though he was pleased to find that he had now a convincing proof of the planet's motion, he was surprised that the spots moved from south to north in the lower part of the disk, and from north to south in the upper part; a kind of motion of which we have no example, except in the librations of the moon. This, however, was occasioned by the situation of the planet's axis. Cassini expected to have found the rotation of Venus similar to that of Jupiter and Mars, both of which have their axes perpendicular to their respective orbits, and turn round according to the order of the signs; so that, in each of them, the motion of the inferior half of their respective globe, or that part next the sun, is from east to west; in the superior half from west to east; but in Venus, whose axis is inclined 75 degrees towards her orbit, the coincidence is so near, that one-half of her disk appears to move from south to north, the other from north to south.

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67 Why the spots seem to move south to north, &c.

68 Particular account of the appearances of the spots at different times.

On the 21st of April, at sunrise, the bright part was a good way off the section, and about a fourth-part of the diameter distant from the southern horn. When the sun was eight degrees six minutes high, it seemed to be got beyond the center, and was cut through by the section. At the time the sun was seven degrees high the section cut it in the middle, which showed its motion to have some inclination towards the centre.

May 9. a little before sunrise, the bright spot was seen near the centre, a little to the northward, with two obscure ones situated between the section and the circumference, at a distance from each other, equal to that of each of them from the nearest angular point or horn of the planet. The weather being at that time clear, he observed for an hour and half a quarter the motion of the bright spot, which seemed to be exactly from south to north, without any sensible declination to east or west. A variation was at the same time perceived in the darkish spot too great to be ascribed to any optical cause. The bright spot was also seen on the 10th and 13th days of May before sunrise between the northern horn and the centre, and the same irregular change of darkish spots was taken notice of; but as the planet removed to a greater distance from the earth, it became more difficult to observe these appearances. The above phenomena are represented as they occurred in figs. 37—43.

66 Cassini's observations.

69 Cassini's conclusions concerning the revolution of Venus on her axis.

But though, from the appearances just now related, M. Cassini was of opinion that Venus revolved on her axis, he was by no means so positive in this matter as with regard to Mars and Jupiter. "The spots on these (says he) I could attentively observe for a whole night, when the planets were in opposition to the sun:

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I could see them return to the same situation, and consider their motion during some hours, and judge whether they were the same spots or not, and what time they took in turning round: but it was not the same with the spots of Venus; for they can be observed only for so short a time, that it is much more difficult to show with certainty when they return into the same situation. I can, however, supposing that the bright spot which I observed on Venus, and particularly this year, was the same, say that she finishes her motion, whether of rotation or libration, in less than a day; so that, in 23 days nearly, the spot comes into the same situation on nearly the same hour of the day, though not without some irregularity. Now supposing the bright spot observed to be always the same) whether this motion is an entire turning round or only a libration, is what I dare not positively affirm."

70 Difficulties attending these observations.

In 1669 M. Cassini again observed Venus through a telescope, but could not then perceive any spots upon her surface; the reason of which Du Hamel conjectures to have been the fluctuation of the vapours near the horizon, which prevented them from being visible. However, we hear nothing more of any spots being seen on her disk till the year 1726; when, on the 9th of February, Bianchini, with some of Campani's telescopes of 90 and 100 Roman palms, began to observe the planet at the altitude of 40° above the horizon, and continued his observations till, by the motion of several spots, he determined the position of her axis to be inclined as above mentioned, that the north pole pointed at a circle of latitude drawn through the 20th degree of Aquarius, elevated 15 or 20° above the orbit of Venus. He delineated also the figures of several spots which he supposed to be seas, and complimented the king of Portugal and some other great men by calling them by their names. Though none of Bianchini's observations were continued long enough to know whether the spots, at the end of the period assigned for the rotation of the planet, would have been in a different situation from what they were at the beginning of it; yet, from observations of two and of four days, he concluded the motion of the spots to be at the rate of 15° per day; at which advance the planet must turn round either once in 24 days or in 23 hours; but without farther observation it could not be determined which of the two was the period of revolution; for if an observer should at a particular hour, suppose seven in the evening, mark exactly the place of a spot, and at the same hour next evening find the spot advanced 15°, he would not be able to determine whether the spot had advanced only 15°, or had gone once quite round with the addition of 15° more in part of another rotation. Mr Bianchini, however, supposes Venus to revolve in 24 days eight hours; the principal proof adduced for which is an observation of three spots, A B C, being situated as in fig. 44. when they were viewed by himself and several persons of distinction for about an hour, during which they could not perceive any change of place. The planet being then hid behind Barbarine palace, they could not have another view of her till three hours after, when the spots still appeared unmoved. "Now (says M. Bianchini) if her rotation were so swift as to go round in 23 hours, in this second view, three hours after the former, the spots must have advanced near 50 degrees; so that the spot C would have been gone off at R, the spot B would have succeeded into the place of C, the spot A into the place of B, and there would have been no more but two spots, A and B, to have been seen."

71 Bianchini's observations.

72 Doubts concerning the time she takes up in revolving round her axis.

Plate LXVI.

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Cassini, the son, in a memoir for 1732, denies the conclusion of Bianchini to be certain. He says, that, during the three hours interval, the spot C might be gone off the disk, and the spot B got into the place thereof, where, being near the edge, it would appear less than in the middle. That A, succeeding into the place of B, would appear larger than it had done near the edge, and that another spot might come into the place of A; and there were other spots besides these three on the globe of the planet, as appears by the figures of Bianchini himself, particularly one which would naturally come into the place of A. That if the rotation of Venus be supposed to be in 23 hours, it will agree with Bianchini's, observations, as well as with those of his father; but that, on the other supposition, the latter must be entirely rejected as erroneous: and he concludes with telling us, that Venus had frequently been observed in the most favourable times by M. Maraldi and himself with excellent telescopes of 80 and 100 feet focus, without their being able to see any distinct spot upon her disk. "Perhaps, (says Dr Long), those seen by Bianchini had disappeared, or the air in France was not clear enough; which last might be the reason why his father could never see those spots in France which he had observed in Italy, even when he made use of the longest telescopes. Neither of these astronomers take notice of any indentings in the curve which divides the illuminated part from the dark in the disk of Venus, though in some views of that planet by Fontana and Ricciolus, the curve is indented; and it has from thence been concluded, thatthe surface of the planet is mountainous like that of the moon. This had also been supposed by Burratini, already mentioned; and a late writer has observed, that 'When the air is in a good state for observation, mountains like those of the moon may be observed with a very powerful telescope.'

73 Dispute between Cassini and Bianchini.

74 Cassini discovers her satellite.

Cassini, besides the discovery of the spots on the disk of Venus by which he was enabled to ascertain her revolution on an axis, had also a view of her satellite or moon, of which he gives the following account.—"A. D. 1686, Aug. 28th, at 15 minutes after four in the morning, looking at Venus with a telescope of 34 feet, I saw, at the distance of one-third of her diameter, eastward, a luminous appearance, of a shape not well defined, that seemed to have the same phase with Venus, which was then gibbous on the western side. The diameter of this phenomenon was nearly equal to a fourth part of the diameter of Venus. I observed it attentively for a quarter of an hour, and having left off looking at it for four or five minutes, I saw it no more; but day-light was then advanced. I had seen a like phenomenon which resembled the phase of Venus, Jan. 25th, A. D. 1672, from 52 minutes after six in the morning to two minutes after seven, when the brightness of the twilight made it disappear. Venus was then horned, and this phenomenon, the diameter whereof was nearly a fourth-part of the diameter of Venus, was of the same shape. It was distant from the southern horn of Venus, a diameter of the planet,

on

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on the western side. In these two observations, I was in doubt whether it was not a satellite of Venus of such a consistence as not to be very well fitted to reflect the light of the sun; and which, in magnitude bore nearly the same proportion to Venus as the moon does to the earth, being at the same distance from the sun and the earth as Venus was, the phases whereof it resembled. Notwithstanding all the pains I took in looking for it after these two observations, and at divers other times, in order to complete so considerable a discovery, I was never able to see it. I therefore suspend my judgment of this phenomenon. If it should return often, there will be these two epochas, which, compared with other observations, may be of use to find out the periodical time of its return, if it can be reduced to any rule."

75 Discovered also by Mr Short.

A similar observation was made by Mr Short on the 23d of October 1740, about sunrise. He used at this time a reflecting telescope of about 16.5 inches, which magnified between 50 and 60 times, with which he perceived a small star at about 10′ distance from Venus, as measured by the micrometer; and putting on a magnifying power of 240 times, he found the star put on the same appearance with the planet herself. Its diameter was somewhat less than a third of that of the primary, but its light was less vivid, though exceedingly sharp and well defined. The same appearance continued with a magnifying power of 140 times. A line, passing through the centre of Venus and it, made an angle of 18 or 20 degrees with the equator: he saw it several times that morning for about the space of an hour, after which he lost sight of it, and could never find it again.

From this time the satellite of Venus, though very frequently looked for by Astronomers, could never be perceived, which made it generally believed that Cassini and Mr Short had been mistaken; but as the transits of the planet over the sun in 1761 and 1769 seemed to promise a greater certainty of finding it, the satellite was very carefully looked for by almost every one who had an opportunity of seeing the transit, but generally without success. M. Baudouin at Paris had provided a telescope of 25 feet, in order to observe the passage of the planet over the sun, and to look for its satellite; but he did not succeed either at that time or in the months of April and May following. M. Montaigne, however, one of the members of the Society of Limoges, had better success. On the 3d of May 1761, he perceived, about half an hour after nine at night, at the distance of 20′ from Venus, a small crescent, with the horns pointing the same way as those of the planet; the diameter of the former being about one-fourth of that of the latter; and a line drawn from Venus to the satellite making an angle with the vertical of about 20° towards the south. But though he repeated this observation several times, some doubt remained whether it was not a small star. Next day he saw the same star at the same hour, distant from Venus about half a minute, or a minute more than before, and making with the vertical an angle of 10° below on the north side; so that the satellite seemed to have described an arc of about 30°, whereof Venus was the centre, and the radius 20′. The two following nights were hazy, so that Venus could only be seen; but on the 7th of May, at the same hour as before, he saw

76 Seen by M. Montaigne at the transit in 1761.

the satellite again above Venus, and on the north side, at the distance of 25 or 26′ upon a line which made an angle of about 45°, with the vertical towards the right hand. The light of the satellite was always very weak, but it had the same phasis with its primary, whether viewed together with it in the field of his telescope or by itself. The telescope was nine feet long, and magnified an object between 40 and 50 times, but had no micrometer; so that the distance abovementioned are only from estimation.

Fig. 4. Represents the three observations of M. Montaigne. V is the planet Venus; ZN the vertical. EC, a parallel to the ecliptic, making then an angle with the vertical of 45°; the numbers 3, 4, 7, mark the situations of the satellite on the respective days. From the figure it appears that the points 3 and 7 would have been diametrically opposite, had the satellite gone 15° more round the point V at the last observation; so that in four days it went through 155°. Then, as 155° is to four days or 96 hours, so is 360 to a fourth number, which gives 9 days 7 hours for the whole length of the synodical revolution. Hence M. Baudouin concluded, that the distance of this satellite was about 60 of the semidiameters of Venus from its surface; that its orbit cut the ecliptic nearly at right angles; had its ascending node in 22° of Virgo; and was in its greatest northern digression on the 7th atnine at night; and he supposed, that at the transit of the primary the satellite would be seen accompanying it. By a subsequent observation, however, on the 11th of May, he corrected his calculation of the periodical time of the satellite, which he now enlarged to 12 days; in consequence of which he found that it would not pass over the disk of the sun along with its primary, but go at the distance of above 20′ from his southern limb; though if the time of its revolution should be 15 hours longer than 12 days, it might then pass over the sun after Venus was gone off. He imagined the reason why this satellite was so difficult to be observed, might be, that one part of its globe was crusted over with spots, or otherwise unfit to reflect the light of the sun. By comparing the periodical time of this satellite with that of our moon, he computed the quantity of matter in Venus to be nearly equal to that in our earth; in which case it must have considerable influence in changing the obliquity of the ecliptic, the latitudes and longitudes of stars, &c.

Plate LX.

77 Why this satellite is so difficult to be seen.

This is all the evidence which has yet been published concerning the existence of the satellite of Venus; as it does not appear that, during the transit of 1769, any of the observers had the good fortune to perceive it. In the Philosophical Transactions for 1761, Mr Hirst gives an account of his having observed an atmosphere round the planet Venus. The observations were made at Fort St George; and looking attentively at that part of the sun's disk where he expected the planet would enter, he plainly perceived a faint shade or penumbra; on which he called out to his two assistants, "'Tis a coming!' and two or three seconds after, the first external contact took place in the moment whereof all the three agreed; but he could not see the penumbra after the egress: and of the other two gentlemen, one had gone home, and the other lost the planet out of the field of his telescope. Mr Dunn at Chelsea saw a penumbra, or small diminution of light,

78 Observations concerning the atmosphere of Venus.

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light, that grew darker and darker for about five seconds before the internal contact preceding the egress; from whence he determines that Venus is surrounded with an atmosphere of about 50 geographical miles high. His observations, he tells us, were made with an excellent six-feet Newtonian reflector, with a magnifying power of 110, and of 220 times: he had a clear dark glass next his eye, and the sun's limb appeared well defined; but a very narrow waterish penumbra appeared round Venus. The darkest part of the planet's phasis was at the distance of about a sixth-part of her diameter from its edge; from which an imperfect light encreased to the centre, and illuminated round about.

In the northern parts of Europe this penumbra could not be seen. Mr Wargentin, who communicated several observations of the first external contact, says, that he could not mark the time exactly, because of the undulation of the limb of the sun; but thought it very remarkable that, at the egress, the limb of Venus that was gone off the sun showed itself with a faint light during almost the whole time of emersion. Mr. Bergman, who was then at the observatory at Upsal, begins his account at the time when three-fourths of the disk of the planet was entered upon that of the sun; and he says, that the part which was not come upon the sun was visible, though dark, and surrounded
Plate LXI. by a crescent of faint light, as in fig. 7.: but this appearance was much more remarkable at the egress; for as soon as any part of the planet was got off the sun, that part was visible with a like crescent, but brighter, fig. 8. As more of the planetary disk went off that of the sun, however, that part of the crescent which was farthest from the sun grew fainter, and vanished, until at last only the horns could be seen, as in fig. 9. The total ingress was not instantaneous: but, as two drops of water, when about to part, form a ligament between them; so there was a dark swelling stretched out between Venus and the sun, as in fig. 10.; and when this ligament broke, the planet appeared to have got about an eighth-part of her diameter from the nearest limb of the sun; fig. 11. he saw the like appearance at going off, but not so distinct, fig. 12. Mr Chappe likewise took notice, that the part of Venus which was not upon the sun was visible during part of the time of ingress and egress; that it was farther surrounded by a small luminous ring of a deep yellow near the place that appeared in the form of the crescent, which was much brighter at the going off than coming upon the sun; and that, during the whole time the disk of Venus was upon the sun, he saw nothing of it. The time of the total ingress was instantaneous like a flash of lightening; but at the egress the limb of the sun began to be obscured three seconds before the interior contact. Some of the French astronomers attributed this luminous ring round Venus to the inflection of the sun's rays, as they also do the light seen round the moon in solar eclipses; but Mr Chappe supposes it to have been owing to the sun enlightening more than one half of the planetary globe, though he owns this cause not to be altogether sufficient. Mr Fouchy, who observed the transit at La Muette in France, perceived, during the whole time, a kind of ring round Venus, brighter than the rest of the sun, which became fainter the farther it went from the planet, but appeared more vivid in proportion as the sun was clearer. Mr. Ferner, who observed at the same place, confirms the testimony of Mr Fouchy. "During the whole time (says he) of my observing with the telescope, and the blue and green glasses, I perceived a light round about Venus, which followed her like a luminous atmosphere more or less lively, according as the air was more or less clear. Its extent altered in the same manner; nor was it well terminated; throwing out, as it were, some feeble rays on all sides."

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79
Dr Long's opinion on these observations.

"I am not clear (says Dr. Long) as to the meaning of the luminous circle here mentioned, whether, when the whole planet was upon the sun, they saw a ring of light round it, distinct from the light of the sun; or whether they mean only the light which surrounded that part of Venus that was not upon the sun." Mr Chappe takes this and other accounts of the observations made in France in this latter sense: and though he sometimes called the luminous part of the crescent that surrounded the part of the planet not upon the sun a ring, he explains himself, that he did so, because at the coming upon the sun he perceived it at one side of the planet, and on the opposite side on its going off: for which reason he supposed that it surrounded it on all sides. See fig. 13. 14.

80
Spots when first seen on Mars.

5. Much larger and more remarkable spots have been perceived on the disk of Mars than that of any other primary planet. They were first observed in 1666 by Cassini at Bologna, with a telescope of Campani about 16½ feet long; and continuing to observe them for a month, he found they came into the same situation in 24 hours and 40 minutes. The planet was observed by some astronomers at Rome with longer telescopes made by Eustachio Divini; but they assigned to it a rotation in 13 hours only. This, however, was afterwards shown by Mr Cassini to have been a mistake, and to have arisen from their not distinguishing the opposite sides of the planet, which it seems have spots pretty much alike. He made further observations on the spots of this planet in 1670; from whence he drew an additional confirmation of the time the planet took to revolve. The spots were again observed in subsequent oppositions; particularly for several days in 1704 by Maraldi, who took notice that they were not always well defined, and that they not only changed their shape frequently in the space between two oppositions, but even in the space of a month. Some of them, however, continued of the same form long enough to ascertain the time of the planet's revolution. Among these there appeared this year an oblong spot, resembling one of the belts of Jupiter when broken. It did not reach quite round the body of the planet; but had, not far from the middle of it, a small protuberance towards the north, so well defined that he was thereby enabled to settle the period of its revolution at 24 hours 39 minutes; only one minute less than what Cassini had determined it to be. See Plate LXVIII. fig. 45.

The near approach of Mars to the earth in 1719 gave a much better opportunity of viewing him than had been obtained before; as he was then within 2½ deg. of his perihelion, and at the same time in opposition to the sun. His apparent magnitude and brightness were thus so much increased, that he was by the vulgar taken for a new star. His appearance at that time,

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time, as seen by Maraldi through a telescope of 34 feet long, is represented fig. 46. There was then a long belt that reached half way round, to the end of which another shorter belt was joined, forming an obtuse angle with the former, as in fig. 47. This angular point was observed on the 19th and 20th of August, at 11 hours 15 minutes, a little east of the middle of the disk; and 37 days after, on the 25th and 26th of September, returned to the same situation. This interval, divided by 36, the number of revolutions contained in it gives 24 hours 40 minutes for the period of one revolution; which was verified by another spot of a triangular shape, one angle whereof was towards the north pole, and the base towards the south, which on the 5th and 6th of August appeared as in fig. 48. and after 72 revolutions returned to the same situation on the 16th and 17th of October. The appearances of Mars, as delineated by Mr Hook, when viewed through a 36 feet telescope, are represented fig. 28. He appeared through this instrument as big as the full moon. Some of the belts of this planet are said to be parallel to his equator; but that seen by Maraldi was very much inclined to it.

Plate LXVII.

Plate LXIV.

81 Bright spots about the poles of Mars.

Besides these dark spots, the former astronomers took notice, that a segment of his globe about the south pole exceeded the rest of his disk so much in brightness, that it appeared beyond them as if it were the segment of a larger globe. Maraldi informs us, that this bright spot had been taken notice of for 60 years, and was more permanent than the other spots on the planet. One part of it is brighter than the rest, and the least bright part is subject to great changes, and has sometimes disappeared.

A similar brightness about the north pole of Mars was also sometimes observed; and these observations are now confirmed by Mr Herschel, who hath viewed the planet with much better instruments, and much higher magnifying powers than any other astronomer ever was in possession of. His observations were made with a view to determine the figure of the planet, the position of his axis, &c. A very particular account of them is given in the 74th volume of the Philosophical Transactions, but which our limits will not allow us to insert. Figs 49—72. show the particular appearances of Mars, as viewed on the days there marked. The magnifying powers he used were sometimes as high as 932; and with this the south polar spot was found to be in diameter 41‴. Fig. 73 shows the connection of the other figures marked 64, 65, 66, 67, 68, 69, 70, which complete the whole equatorial succession of spots on the disk of the planet. The centre of the circle marked 65 is placed on the circumference of the inner circle, by making its distance from the circle marked 67 answer to the interval of time between the two observations, properly calculated and reduced to sidereal measure. The same is done with regard to the circles marked 66, 67, &c.; and it will be found by placing any one of these connected circles in such a manner as to have its contents in a similar situation with the figures in the single representation, which bears the same number, that there is a sufficient resemblance between them; though some allowance must undoubtedly be made for the distortions occasioned by this kind of projection.

82 Mr Herschel's account of these spots.

Plate LXVII.

With regard to the bright spots themselves, Mr Herschel informs us, that the poles of the planet are not exactly in the middle of them, though nearly so. "From the appearance and disappearance (says he) of the bright north polar spot in the year 1781, we collect that the circle of its motion was at some considerable distance from the pole. By calculation, its latitude must have been about 76 or 77° north; for I find that, to the inhabitants of Mars, the declination of the sun, June 25th, 12 hours 15 minutes of our time was about 9° 56′ south; and the spot must have been so far removed from the north pole as to fall a few degrees within the enlightened part of the disk to become visible to us. The south pole of Mars could not be many degrees from the centre of the large bright southern spot of the year 1781; though this spot was of such a magnitude as to cover all the polar regions farther than the 70th or 65th degree; and in that part which was on the meridian, July 3d, at 10 hours 54 minutes, perhaps a little farther.

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83 Causes of the appearance and disappearance of these spots.

"From the appearances of the south polar spot in 1781, we may conclude that its centre was nearly polar. We find it continued visible all the time Mars revolved on his axis; and to present us generally with a pretty equal share of the luminous appearance, a spot which covered from 45 to 60° of a great circle on the globe of the planet, could not have any considerable polar distance. From the observations and calculations made concerning the poles of Mars, we may conclude, that his north pole must be directed towards some point of the heavens, between 9ˢ 24° 35′ and 0ˢ 7° 15′; because the change of the situation of the pole from left to right, which happened in the time the planet passed from one place to the other, is a plain indication of its having gone through the node of its axis. Next, we may also conclude, that the node must be considerably nearer the latter point of the ecliptic than the former; for, whatever be the inclination of the axis, it will be seen under equal angles at equal distances from the node. But by a trigonometrical process of solving a few triangles, we soon discover both the inclination of the axis and the place where it intersects the ecliptic at rectangles (which, for want of a better term, I have perhaps improperly called it *node*). Accordingly I find by the calculation, that the node is in 17° 47′ of Pisces, the north pole of Mars being directed towards that part of the heavens; and that the inclination of the axis to the ecliptic is 59° 40′. By further calculations we find that the pole of Mars, on the 17th of April 1777, was then actually 81° 27′ inclined to the ecliptic, and pointed towards the left as seen from the sun.

84 Of the exact position of the poles of Mars.

"The inclination and situation of the node of the axis of Mars, with respect to the ecliptic, being found, may be thus reduced to the orbit of the planet himself. Let E C (fig. 74.) be a part of the ecliptic, O M part of the orbit of Mars, P E O a line drawn from P, the celestial pole of Mars, through E, that point which has been determined to be the place of the node of the axis of Mars in the ecliptic, and continued to O, where it intersects his orbit. Now, if, according to M. de La Lande, we put the node of the orbit of Mars for 1783 in 1ˢ 17° 58′, we have from the place of the node of the axis, that is, 11ˢ 17° 47′, to the place of the node of the orbit, an arch E N of 60° 11′. In the triangle N E O, right angled

Plate LXVIII.

Fig. 26

The Principal fixed Stars in the North Hemisphere Delineated on the Plane of the Equator

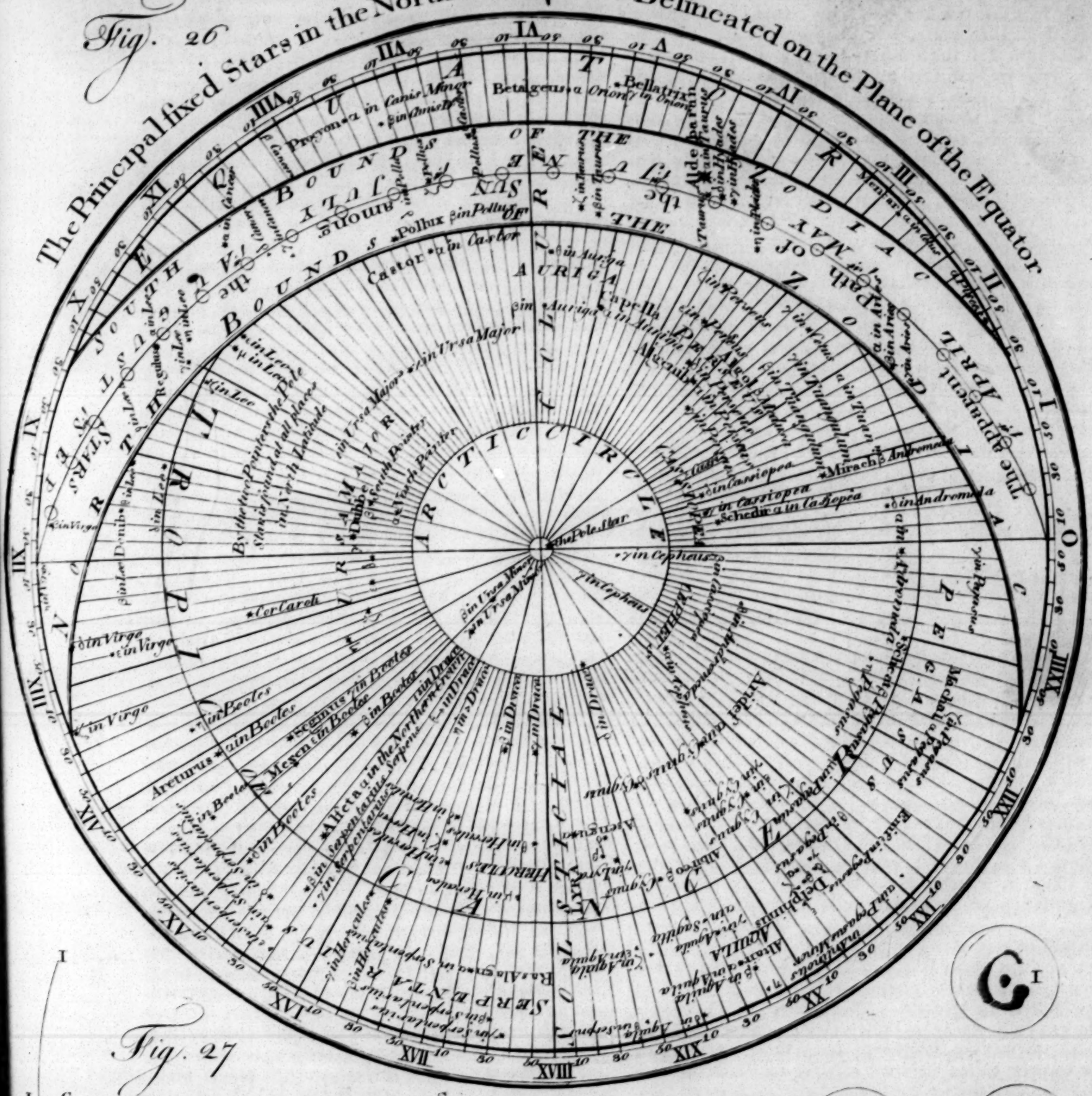

Fig. 27

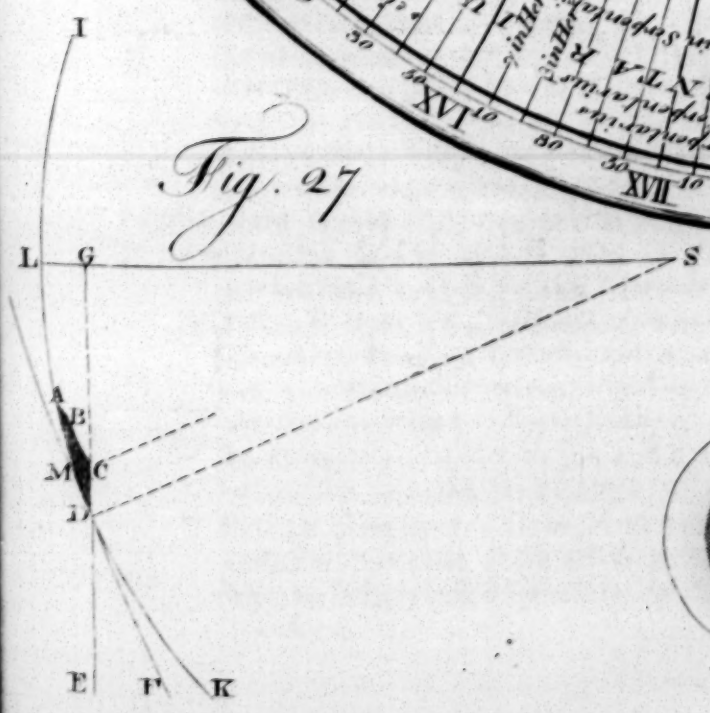

Fig. 28

Sart. Philad.a

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at E, there is also given the angle E N O, according to the same author, 1° 51′, which is the inclination of the orbit of Mars to the ecliptic. Hence we find the angle E O N 89° 5′, and the side O N 60° 12′. Again, when Mars is in the node of its orbit N, we have by calculation the angle P N E = 63° 7′; to which adding the angle E N O = 1° 51′, we have P N O = 64° 58′: from which two angles, P O N and P N O, with the distance O N, we obtain the inclination of the axis of Mars, and place of its node with respect to its own orbit; the inclination being 61° 18′, and the place of the node of the axis 58° 31′ preceding the intersection of the ecliptic with the orbit of Mars, or in our 19° 28′ of Pisces."

85 Of the seasons in Mars.

Our author next proceeds to show how the seasons in this planet may be calculated, &c. Which conjectures, though they belong properly to the next section, yet are so much connected with what has gone before, that we shall insert here what he says upon the subject.

"Being thus acquainted with what the inhabitants of Mars will call the obliquity of their ecliptic, and the situation of their equinoctial and solstitial points, we are furnished with the means of calculating the seasons on that planet, and may account, in a manner which I think highly probable, for the remarkable appearance about its polar regions.

"But first, it may not be improper to give an instance how to resolve any query concerning the Martial seasons. Thus, let it be required to compute the declination of the sun on Mars, June 25. 1781, at midnight of our time. If ♈, ♉, ♊, ♋, &c. (fig. 75.) represent the ecliptic of Mars, and ♈ ♋ ♎ ♑ the ecliptic of our planet, A *a*, *b* B, the mutual intersection of the Martial and terrestrial ecliptics, then there is given the heliocentric longitude of Mars, ♈ *m* = 9ˢ 10° 30′: then taking away six signs, and ♎ *b* or ♈ *a* = 1ˢ 17° 58′, there remains *b m* = 1ˢ 22° 32′. From this arch, with the given inclination, 1° 51′ of the orbits to teach other, we have cosine of inclination to radius, as tangent of *b m* to tangent of B M = 1ˢ 22° 33′. And taking away B ♈ = 1ˢ 1° 29′, which is the complement to ♑ B (or ♋ A, already shown to be 1ˢ 28° 31′), there will remain ♈ M = 0ˢ 21° 4′, the place of Mars in its own orbit; that is, on the time above mentioned, the sun's longitude on Mars will be 6ˢ 21° 4′; and the obliquity of the Martial ecliptic, 28° 42′, being also given, we find, by the usual method, the sun's declination, 9° 56′ south.

86 Considerable resemblance betwixt the earth and Mars.

"The analogy between Mars and the earth is perhaps by far the greatest in the whole solar system. Their diurnal motion is nearly the same; the obliquity of their respective ecliptics not very different; of all the superior planets, the distance of Mars from the sun is by far the nearest alike to that of the earth: nor will the length of the Martial year appear very different from what we enjoy, when compared to the surprising duration of the years of Jupiter, Saturn, and the Georgium Sidus. If then we find that the globe we inhabit has its polar regions frozen and covered with mountains of ice and snow, that only partly melt when alternately exposed to the sun, I may well be permitted to surmise, that the same causes may probably have the same effect on the globe of Mars; that the bright polar spots are owing to the vivid reflection of light from frozen regions; and that the reduction of those spots is to be ascribed to their being exposed to the sun. In the year 1781, the south polar spot was extremely large, which we might well expect as that pole had but lately been involved in a whole twelvemonth's darkness and absence of the sun; but in 1783, I found it considerably smaller than before, and it decreased continually from the 20th of May till about the middle of September, when it seemed to be at a stand. During this last period the south pole had already been above eight months enjoying the benefit of summer, and still continued to receive the sun-beams, though, towards the latter end, in such an oblique direction as to be but little benefited by them. On the other hand, in the year 1781, the north polar spot, which had then been its twelvemonth in the sunshine, and was but lately returning into darkness, appeared small, though undoubtedly increasing in size. Its not being visible in the year 1783, is no objection to these phenomena; being owing to the position of the axis, by which it was removed out of sight.

88 Of the spheroidal form of Mars.

"That a planetary globe, such as Mars, turning on an axis, should be of a spheroidical form, will easily find admittance, when two familiar instances in Jupiter and the earth, as well as the known laws of gravitation and the centrifugal force of rotatory bodies, lead the way to the reception of such doctrines. So far from creating difficulties or doubts, it will rather appear singular, that the spheroidical form of this planet has not already been noticed by former astronomers; and yet, reflecting on the general appearances of Mars, we soon find, that opportunities of making observations on its real form cannot be very frequent: for when it is near enough to view it to an advantage, we see it generally gibbous; and its appositions are so scarce, and of so short a duration, that in more than two years time we have not above three or four weeks for such observations. Besides, astronomers being generally accustomed to see this planet distorted, the spheroidical form might easily be overlooked.

89 Difference betwixt the equatorial and polar diameters of Mars.

"September 25. 1783. At 9h. 50′, the equatorial diameter of Mars measured 21″ 53‴; the polar diameter 21″ 15‴, *full measure*; that is certainly not too small. This difference of the diameters was shown, on the 28th of the same month, to Mr Wilson of Glasgow, who saw it perfectly well, so as to be convinced that it was not owing to any defect or distortion occasioned by the lens: and because I wished him to be satisfied of the reality of the appearance, I reminded him of several precautions; such as causing the planet to pass directly through the centre of the field of view, and judging of its figure when it was most distinct and best defined, &c. Next day the difference between the two diameters was shown to Dr Blagden and Mr Aubert. The former not only saw it immediately, but thought the flattening almost as much as that of Jupiter. Mr Aubert also saw it very plainly, so as to entertain no manner of doubt about the appearance.

"September 30th, 10h. 52′, the equatorial diameter was 22″ 9‴, with a magnifying power of 278. By a second measure it was 22″ 31‴, full large; the polar diameter, very exact, was 21″ 26‴. On the 1st of October, at 10h. 50′, the equatorial diameter measured 103 by the micrometer, and the polar 98; the value of the divisions in seconds and thirds not being well

87 White spots about the poles of Mars supposed to be occasioned by snow.

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determined, on account of some changes lately made in the focal length of the object metals of the telescope. On the 13th, the equatorial diameter was exactly 22″ 35‴; the polar diameter 21″ 33‴." In a great number of succeeding observations, the same appearance occurred; but on account of the quick changes in the appearance of this planet, Mr Herschel thought proper to settle the proportion betwixt the equatorial and polar diameters from those which were made on the very day of the apposition, and which were also to be preferred on account of their being repeated with a very high power, and in a fine clear air, with two different instruments of an excellent quality. From these he determined the proportions to be as 103 to 98, or 1355 to 1272.

90 Of the atmosphere of Mars.

It has been commonly related by astronomers, that the atmosphere of this planet is possessed of such strong refractive powers, as to render the small fixed stars near which it passes invisible. Dr Smith relates an observation of Cassini, where a star in the water of Aquarius, at the distance of six minutes from the disk of Mars, became so faint before its occultation that it could not be seen by the naked eye, nor with a three-feet telescope. This would indicate an atmosphere of a very extraordinary size and density; but the following observations of Mr Herschel seem to show that it is of much smaller dimensions. "1783, Oct. 26th, There are two small stars preceding Mars, of different sizes; with 460 they appear both dusky red, and are pretty unequal; with 278 they appear considerably unequal. The distance from Mars of the nearest, which is also the largest, with 227 measured 3′ 26″ 20‴. Some time after, the same evening, the distance was 3′ 8″ 55‴, Mars being retrograde. Both of them were seen very distinctly. They were viewed with a new 20 feet reflector, and appeared very bright. October 27th, the small star is not quite so bright in proportion to the large one as it was last night, being a good deal nearer to Mars, which is now on the side of the small star; but when the planet was drawn aside, or out of view, it appeared as plainly as usual. The distance of the small star was 2′ 5″ 25‴. The largest of the two stars (adds he), on which the above observations were made, cannot exceed the 12th, and the smallest the 13th or 14th magnitude; and I have no reason to suppose that they were any otherwise affected by the approach of Mars, than what the brightness of its superior light may account for. From other phenomena it appears, however, that this planet is not without a considerable atmosphere; for besides the permanent spots on its surface, I have often noticed occasional changes of partial bright belts, and also once a darkish one in a pretty high latitude; and these alterations we can hardly ascribe to any other cause than the variable disposition of clouds and vapours floating in the atmosphere of the planet."

91 Belts of Jupiter, when first discovered.

6. Jupiter has the same general appearance with Mars, only that the belts on his surface are much larger and more permanent. Their general appearance, as described by Dr Long, is represented fig. 76—79.; by Mr Dun, fig. 18.; by Mr Wollaston fig. 21. 22, 22.; and by Mr Ferguson, fig. 153. But they are not to be seen but by an excellent telescope. They are said to have been first discovered by Fontana and two other Italians; but Cassini was the first who gave a good account of them. Their number is very variable, as sometimes only one, and at others no fewer than eight, may be perceived. They are generally parallel to one another, but not always so; and their breadth is likewise variable, one belt having been observed to grow narrow, while another in its neighbourhood has increased in breadth, as if the one had flowed into the other: and in this case Dr Long observes, that a part of an oblique belt lay between them, as if to form a communication for this purpose. The time of their continuance is very uncertain, sometimes remaining unchanged for three months; at others, new belts have been formed in an hour or two.

92 Spots sometimes appear in them.

In some of these belts large black spots have appeared, which moved swiftly over the disk from east to west, and returned in a short time to the same place; from whence the rotation of this planet about its axis has been determined. On the 9th of May 1664, Dr Hook, with a good 12 feet telescope, observed a small spot in the biggest of the three obscure belts of Jupiter; and observing it from time to time, found that in two hours it had moved from east to west about half the visible diameter of the planet. In 1665, Cassini observed a spot near the largest belt of Jupiter which is most frequently seen. It appeared round, and moved with the greatest velocity when in the middle, but appeared narrower, and moved slower, the nearer it was to the circumference. "These circumstances (says Dr Long), showed that the spot adhered to the body of Jupiter, and was carried round upon it. It continued thereon till the year following; long enough to determine the periodical time of Jupiter's rotation upon his axis to be nine hours 56 minutes." This principal, or ancient spot as it is called, is the largest, and of the longest continuance of any hitherto known, has appeared and vanished no fewer than eight times between the years 1665 and 1708: from the year last mentioned it was invisible till 1713. The longest time of its continuing to be visible was three years; and the longest time of its disappearing was from 1708 to 1713: it seems to have some connection with the principal southern belt; for the spot has never been seen when that disappeared, though that belt has often been visible without the spot. Besides this ancient spot, Cassini, in the year 1699, saw one of less stability that did not continue, of the same shape or dimensions, but broke into several small ones, whereof the revolution was but nine hours 51 minutes; and two other spots that revolved in nine hours 52 minutes and a half. The figure of Jupiter is evidently an oblate spheroid, the longest diameter of his disk being to the shortest as 13 to 12. His rotation is from west to east, like that of the sun, and the plane of his equator is very nearly coincident with that of his orbit; so that there can scarce be any difference of seasons in that planet. His rotation has been observed to be somewhat quicker in his aphelion than his perihelion.

93 Account of one these spots.

94 No difference of seasons in Jupiter.

95 Is attended by four moons.

The most remarkable circumstance attending this planet is his having four moons, which constantly revolve round him at different distances. See fig. 18. and 186. These are all supposed to move in ellipses; though the excentricities of all of them are too small to be measured, excepting that of the fourth; and even this amounts to no more than 0.007 of its mean distance from the primary. The orbits of these planets were thought

Fig. 30

Fig. 29

The Principal fixed Stars in the South Hemisphere Delineated on the Plane of the Equator

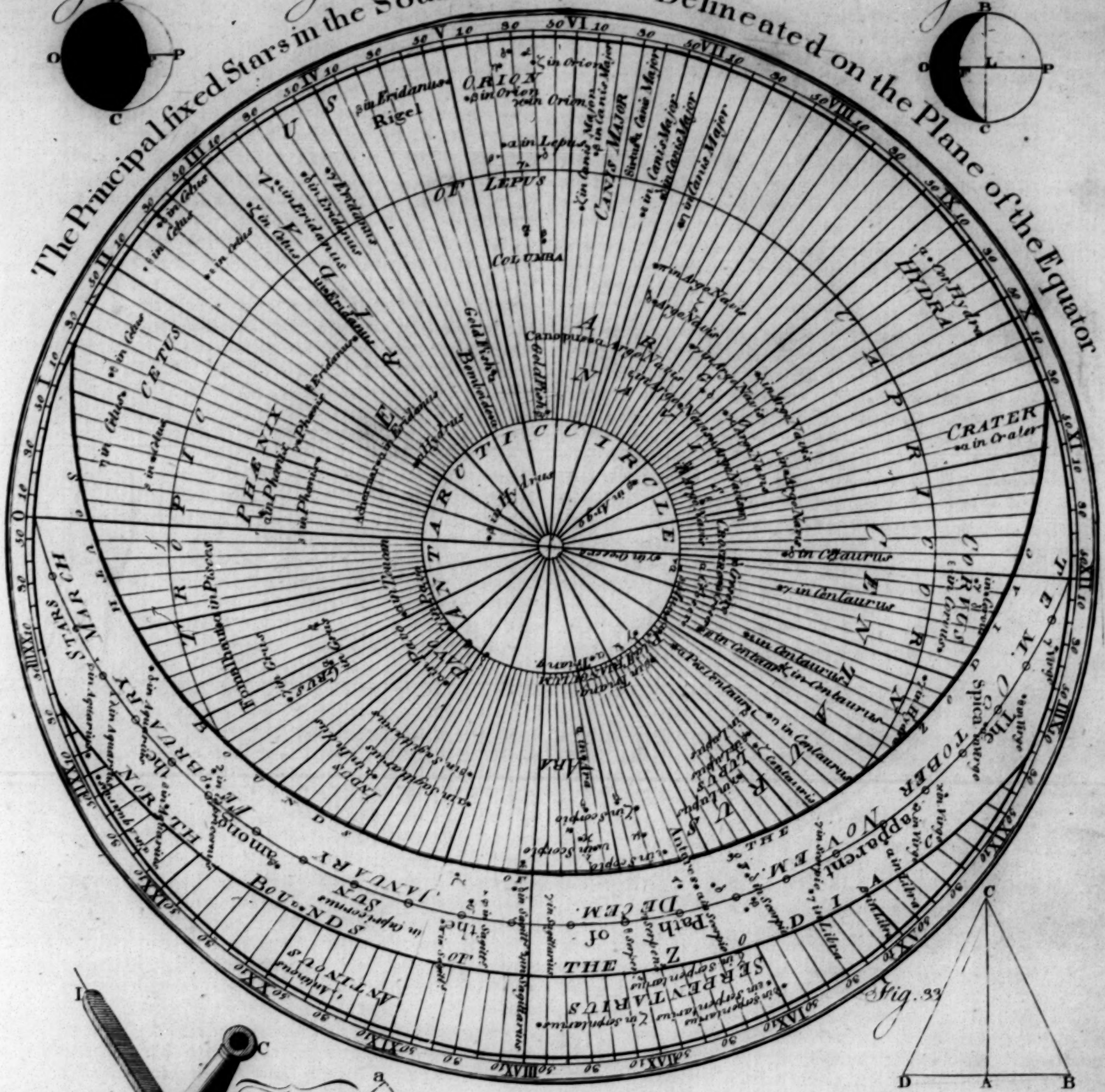

Fig. 31

Fig. 33

Fig. 32

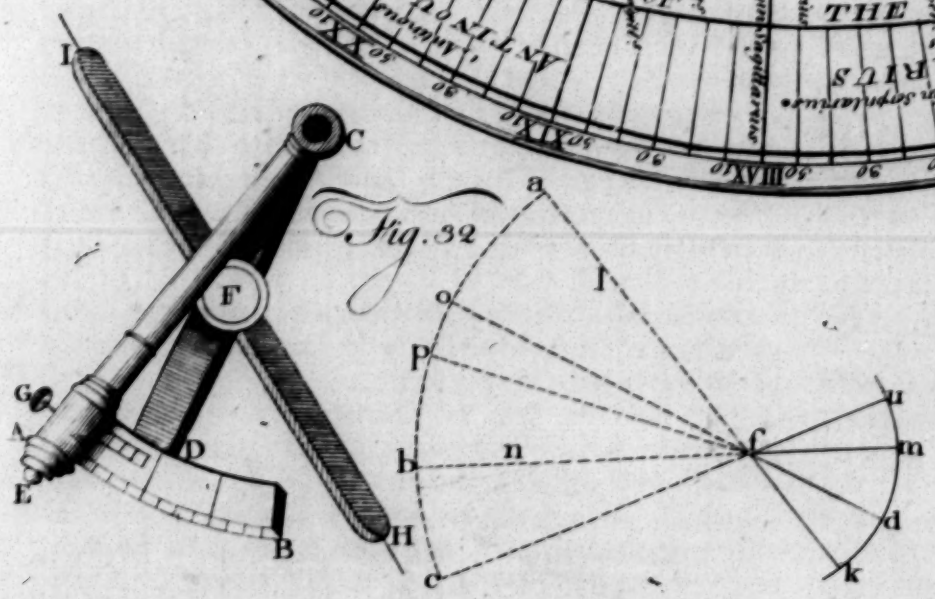

Fig. 34
Comet

Scot Philad.

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thought by Galileo to be in the same plane with that of their primary: but M. Cassini has found that their orbits make a small angle with it; and as he did not find any difference in the place of their nodes, he concluded that they were all in the same place, and that their ascending nodes were in the middle of Aquarius. After observing them for more than 36 years, he found their greatest latitude, or deviation from the plane of Jupiter's orbit, to be 2° 55′. The first of these satellites revolves at the distance of 5.697 of Jupiter's semidiameters, or 1′ 51″ as measured by proper instruments; its periodical time is 1 d. 18 h. 27′ 34″. The next satellite revolves at the distance of 9.017 semidiameters, or 2′ 56″, in 3d. 13 h. 13′ 42″; the third at the distance of 14.384 semidiameters, or 4′ 42″, in 7 d. 3 h. 42′ 36″; and the fourth at the distance of 25.266, or 8′ 16″, in 16 d. 16 h. 32′ 09″.

96 Distances and periodical times of Jupiter's moons.

Since the time of Cassini, it has been found that the nodes of Jupiter's satellites are not in the same place; and from the different points of view in which we have an opportunity of observing them from the earth, we see them sometimes apparently moving in straight lines, and at other times in elliptic curves. All of them, by reason of their immense distance, seem to keep near their primary, and their apparent motion is a kind of oscillation like that of a pendulum, going alternately from the greatest distance on one side to the greatest distance on the other, sometimes in a straight line, and sometimes in an elliptic curve. When a satellite is in its superior semicircle, or that half of its orbit which is more distant from the earth than Jupiter is, its motion appears to us direct, according to the order of the signs; but in its inferior semicircle, when it is nearer to us than Jupiter, its motion appears retrograde; and both these motions seem quicker the nearer the satellites are to the centre of the primary, slower the more distant they are, and at the greatest distance of all they appear for a short time to be stationary.

97 Occultations and eclipses of Jupiter's satellites.

From this account of the system of Jupiter and his satellites, it is evident, that occultations of them must frequently happen by their going behind their primary, or by coming in betwixt us and it. The former takes place when they proceed towards the middle of the upper semicircle; the latter, when they pass through the same part of their inferior semicircle. Occultations of the former kind happen to the first and second satellite; at every revolution, the third very rarely escapes an occultation, but the fourth more frequently by reason of its greater distance. It is seldom that a satellite can be discovered upon the disk of Jupiter, even by the best telescopes, excepting at its first entrance, when by reason of its being more directly illuminated by the rays of the sun than the planet itself, it appears like a lucid spot upon it. Sometimes, however, a satellite in passing over the disk, appears like a dark spot, and is easily to be distinguished. This is supposed to be owing to spots on the body of these secondary planets; and it is remarkable, that the same satellite has been known to pass over the disk at one time as a dark spot, and at another so luminous that it could not be distinguished from Jupiter himself, except at its coming on and going off. To account for this, we must say, that either the spots are subject to change; or if they be permanent, like those of our moon, that the satellites at different times turn different parts of their globes towards us. Possibly both these causes may contribute to produce the phenomena just mentioned. For these reasons also both the light and apparent magnitude of the satellites are variable: for the fewer spots there are upon that side which is turned towards us, the brighter it will appear; and as the bright side only can be seen, a satellite must appear larger the more of its bright side it turns towards the earth, and the less so the more it happens to be covered with spots. The fourth satellite, though generally the smallest, sometimes appears bigger than any of the rest: the third sometimes seems least, though usually the largest; nay, a satellite may be so covered with spots as to appear less than its shadow passing over the disk of the primary, though we are certain that the shadow must be smaller than the body which casts it. To a spectator placed on the surface of Jupiter, each of these satellites would put on the phases of the moon; but as the distance of any of them from Jupiter is but small when compared with the distance of that planet from the sun, the satellites are therefore illuminated by the sun very nearly in the same manner with the primary itself; hence they apper to us always round, having constantly the greatest part of their enlightened half turned towards the earth; and indeed they are so small, that were they to put on the phases of the moon, these phases could scarce be discerned through the best telescopes.

98 The satellites sometimes appear as dark spots

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99 Why they vary in their light and apparent magnitude.

100 Their shadows sometimes visible on the disk of Jupiter.

When the satellites pass through their inferior semicircles, they may cast a shadow upon their primary, and thus cause an eclipse of the sun to his inhabitants if there are any; and in some situations this shadow may be observed going before or following the satellite. On the other hand, in passing through their superior semicircles, the satellites may be eclipsed in the same manner as our moon, by passing through the shadow of Jupiter: and this is actually the case with the first, second, and third of these bodies; but the fourth, by reason of the largeness of its orbit, passes sometimes above or below the shadow, as is the case with our moon. The beginnings and ending of these eclipses are easily seen by a telescope when the earth is in a proper situation with regard to Jupiter and the sun; but when this or any other planet is in conjunction with the sun, the superior brightness of that luminary renders both it and the satellites invisible. From the time of its first appearing after a conjunction until near the opposition, only the immersions of the satellites into his shadow, or the beginnings of the eclipses, are visible; at the opposition, only the occultations of the satellites, by going behind or coming before their primary, are observable; and from the opposition to the conjunction, only the emersions, or end of the eclipses, are to be seen. This is exactly true in the first satellite, of which we can never see an immersion with its immediately subsequent emersion: and it is but rarely that they can be both seen in the second; as in order to their being so, that satellite must be near one of its limits, at the same time that the planet is near his perihelion and quadrature with the sun. With regard to the third, when Jupiter is more than 46 degrees from conjunction with, or opposition to the sun, both its immersions and immediately subsequent emersions are visible; as they likewise are in the fourth, when the distance of Jupiter from conjunction or opposition is 24 degrees.

101 Three of Jupiter's moons eclipsed in every revolution.

102 At what time the eclipses, occultations, &c. of Jupiter's satelites are visible.

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When Jupiter is in quadrature with the sun, the earth is farthest out of the line that passes through the centres of the sun and Jupiter, and therefore the shadow of the planet is then most exposed to our view; but even then the body of the planet will hide from us one side of that part of the shadow which is nearest to it, through which the first satellite passes; which is the reason that, though we see the entrance of that satellite into the shadow, or its coming out from thence, as the earth is situated on the east or west side thereof, we cannot see them both; whereas the other satellites going through the shadow at a greater distance from Jupiter, their ingress and egress are both visible.

103 Telescopic appearance of Saturn.

7. Saturn, when viewed through a good telescope, makes a more remarkable appearance than any of the other planets. Galileo first discovered his uncommon shape, which he thought to be like two small globes, one on each side of a large one: and he published his discovery in a Latin sentence; the meaning of which was, that he had seen him appear with three bodies; though, in order to keep the discovery a secret, the letters were transposed. Having viewed him for two years, he was surprised to see him become quite round without these appendages, and then after some time to assume them as before. These adjoining globes were what are now called the *ansæ* of his ring, the true shape of which was first discovered by Huygens about 40 years after Galileo, first with a telescope of 12 feet, and then with one of 23 feet, which magnified objects 100 times. From the discoveries made by him and other astronomers, it appears that this planet is surrounded by a broad thin ring, the edge of which reflects little or none of the sun's light to us, but the planes of the ring reflect the light in the same manner that the planet itself does; and if we suppose the diameter of Saturn to be divided into three equal parts, the diameter of the ring is about seven of these parts. The ring is detached from the body of Saturn in such a manner, that the distance between the innermost part of the ring and the body is equal to its breadth. If we had a view of the planet and his ring, with our eyes, perpendicular to one of the planes of the latter, we should see them as in fig. 80.: but our eye is never so much elevated above either plane as to have the visual ray stand at right angles to it; nor indeed is it ever elevated more than about 30 degrees above it; so that the ring, being commonly viewed at an oblique angle, appears of an oval form, and through very good telescopes double, as represented fig. 18. and 153. Both the outward and inward rim is projected into an ellipsis, more or less oblong according to the different degrees of obliquity with which it is viewed. Sometimes our eye is in the plane of the ring, and then it becomes invisible; either because the outward edge is not fitted to reflect the sun's light, or more probably because it is too thin to be seen at such a distance. As the plane of this ring keeps always parallel to itself, that is, its situation in one part of the orbit is always parallel to that in any other part, it disappears twice in every revolution of the planet, that is, about once in 15 years; and he sometimes appears quite round for nine months together. At other times, the distance betwixt the body of the planet and the ring is very perceptible; insomuch that Mr Whiston tells us of Dr Clarke's father having seen a star through the opening, and supposed him to have been the only person who ever saw a sight so rare, as the opening, though certainly very large, appears very small to us. When Saturn appears round, if our eye be in the plane of the ring, it will appear as a dark line across the middle of the planet's disk; and if our eye be elevated above the plane of the ring, a shadowy belt will be visible, caused by the shadow of the ring as well as by the interposition of part of it betwixt the eye and the planet. The shadow of the ring is broadest when the sun is most elevated, but its obscure parts appear broadest when our eye is most elevated above the plane of it. When it appears double, the ring next the body of the planet appears brightest; when the ring appears of an elliptical form, the parts about the ends of the largest axis are called the *ansæ*, as has been already mentioned. These, a little before and after the disappearing of the ring, are of unequal magnitude: the largest ansa is longer visible before the planets round phase, and appears again sooner than the other. On the 1st of October 1714, the largest ansa was on the east side, and on the 12th on the west side of the disk of the planet, which makes it probable that the ring has a rotation round an axis: but whether or not this is the case with Saturn himself has not been discovered, on account of the deficiency of spots by which it might be determined. He has indeed two belts, discovered with very long telescopes, which appear parallel to that formed by the edge of the ring above mentioned; but these are rectilinear when the ring appears elliptic, as in fig. 81. and seem to be permanent. In 1683, however, Dom. Cassini and Fatio perceived a bright streak upon Saturn, which was not permanent like the dark belts, but was visible one day and disappeared the next, when another came into view near the edge of his disk. This induced Cassini to suppose, that Saturn might have a rotation round his axis; but the distance of this planet is so great, that we can scarce hope to determine his revolation so accurately as that of the others. It disappeared in May 1789; the earth being about to pass from its northern side, which is enlightened, to the southern, which is obscure.

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104 His ring first discovered by Huygens

105 Ring of Saturn probably has a revolution on its axis.

106 Belts discovered on Saturn.

The astronomer-royal (Dr Maskelyne) informs us of this disappearance in 1789, and reappearance in 1790, in the following manner: "On May 3d and August 26th 1789, the plane of Saturn's ring will pass through the earth; in October 11th it will pass through the sun; and January 29th 1790 it will again pass through the earth. Hence, and supposing with M. de la Lande that the ring is but just visible with the best telescopes in common use, when the sun is elevated 3′ above its plane, or 3 days before the plane passes through the sun, and when the earth is elevated 2½′ above the plane, or one day from the earth's passing it, the phenomena of disappearance and reappearance may be expected to take place as follows.

"May 2d 1789, Saturn's ring will disappear; the earth being about to pass from its northern side, which is enlightened, to its southern side, which is obscure.

"August 27th, the earth having repassed to the northern or enlightened side, the ring will reappear.

"October 8th, the ring will disappear; its plane being near passing through the sun, when it will change its enlightened side from the northern to the southern one,

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one, consequently the dark side will be then turned to the earth.

"January 30th 1790, the earth having passed from the northern or dark side of the ring, to the southern or enlightened one, the ring will become visible, to continue so until the year 1803."

In the diagram, fig. 159 are delineated the phases of the ring from its full appearance in the year 1782 to its disappearance in 1789, and its full reappearance 1796.

107 His five satellites.

Saturn is still better attended than Jupiter (see fig. 18. and 186); having, besides the ring abovementioned, no fewer than five moons continually circulating round him. The first, at the distance of 2.097 semidiameters of his ring, and 4.893 of the planet itself, performs its revolution in 1d. 21h. 18′ 27″; the second, at 2.686 semidiameters of the ring, and 6.268 of Saturn, revolves in 2d. 17h. 41′ 22″: the third, at the distance of 8.754 semidiameters of Saturn, and 3.752 of the ring, in 4d, 12h. 25′ 12″; the fourth, called the *Huygenian satellite*, at 8.698 semidiameters of the ring, and 20.295 of Saturn, revolves in 15d. 21h. 41′ 12″; while the fifth, placed at the vast distance of 59.154 semidiameters of Saturn, or 25.348 of his ring, does not perform its revolution in less than 79d. 7h. 47′ 00″. The orbits of all these satellites, except the fifth, are nearly in the same plane, which makes an angle with the plane of Saturn's orbit of about 31°; and by reason of their being inclined at such large angles, they cannot pass either across their primary or behind it with respect to the earth, except when very near their nodes; so that eclipses of them happen much more seldom than of the satellites of Jupiter. There is, however, an account in the Philos. Transact. of an occultation of the fourth satellite behind the body of Saturn; and there is a curious account by Cassini, in the Memoirs of the Royal Academy for 1692, of a fixed star being covered by the fourth satellite, so that for 13 minutes they appeared both as one star. By reason of their extreme smallness, these satellites cannot be seen unless the air is very clear; and Dom. Cassini for several years observed the fifth satellite to grow less and less as it went through the eastern part of its orbit until it became quite invisible, while in the western part it gradually became more and more bright until it arrived at its greatest splendor.—"This phenomenon (says Dr Long) cannot be better accounted for than by supposing one half of the surface of this satallite to be unfit to reflect the light of the sun in sufficient quantity to make it visible, and that it turns round its axis nearly in the same time as it revolves round its primary; and that, by means of this rotation, and keeping always the same face toward Saturn, we upon the earth may during one half of its periodical time, be able to see successively more and more of its bright side, and during the other half of its period have more and more of the spotted or dark side turned toward us. In the year 1705, this satellite unexpectedly became visible in all parts of its orbit through the very same telescopes that were before often made use of to view it in the eastern part without success: this shows the spots upon this satellite, like those upon Jupiter and some other of the primary planets, are not permanent, but subject to change."

108 Fifth satellite sometimes disappears, and why.

8. With regard to the Georgium Sidus, still less is known than of Saturn. Its apparent magnitude is so small, that it can seldom be seen with the naked eye; and even with the telescope it appears but of a few seconds diameter. It is attended by two satellites at the proportional distances marked in fig. 82. according to the observations of Mr. Herschel; but he had not an opportunity of observing them long enough to determine their periodical times with exactness; though he supposes the innermost to perform its revolution in about eight days and three quarters, the other in thirteen days and a half.

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109 Georgium Sidus attended by two satellites.

110 Of the comets.

9. The Comets, viewed through a telescope, have a very different appearance from any of the planets. The nucleus, or star, seems much more dim. Sturmius tells us, that observing the comet of 1680 with a telescope, it appeared like a coal dimly glowing; or a rude mass of matter illuminated with a dusky fumid light, less sensible at the extremes than in the middle; and not at all like a star, which appears with a round disk and a vivid light.

Hevelius observed of the comet in 1661, that its body was of a yellowish colour, bright and conspicuous, but without any glittering light. In the middle was a dense ruddy nucleus, almost equal to Jupiter, encompassed with a much fainter, thinner matter.—Feb. 5th. The nucleus was somewhat bigger and brighter, of a gold colour, but its light more dusky than the rest of the stars; it appeared also divided into a number of parts.—Feb. 6th. The nuclei still appeared, though less than before. One of them on the left side of the lower part of the disk appeared to be much denser and brighter than the rest; its body round, and representing a little lucid star; the nuclei still encompassed with another kind of matter.—Feb. 10th. The nuclei more obscure and confused, but brighter at top than at bottom.—Feb. 13th. The head diminished much both in brightness and in magnitude.—March 2d. Its roundness a little impaired, and the edges lacerated.—March 28th. Its matter much dispersed; and no distinct nucleus at all appearing.

Wiegelius, who saw through a telescope the comet of 1664, the moon, and a little cloud illuminated by the sun, at the same time; observed that the moon appeared of a continued luminous surface, but the comet very different, being perfectly like the little cloud enlightened by the sun's beams.

111 Their atmospheres and phases.

The comets, too, are to appearance surrounded with atmospheres of a prodigious size, often arising ten times higher than the nucleus. They have often likewise different phases, like the moon.

112 Dr Long's account of them.

"The head of a comet (says Dr Long) to the eye, unassisted by glasses, appears sometimes like a cloudy star; sometimes shines with a dull light like that of the planet Saturn; some comets have been said to equal, some to exceed, stars of the first magnitude; some to have surpassed Jupiter, and even Venus; and to have cast a shadow as Venus sometimes does.

"The head of a comet, seen through a good telescope, appears to consist of a solid globe, and an atmosphere that surrounds it. The solid part is frequently called the *nucleus*; which through a telescope is easily distinguished from the atmosphere or hairy appearance.

"A comet is generally attended with a blaze or tail, whereby it is distinguished from a star or planet;

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as it is also by its motion. Sometimes the tail only of a comet has been visible at a place where the head has been all the while under the horizon; such an appearance is called a *beam*.

113 Appearances of the comet of 1618.

"The nucleus of the comet of 1618 is said, a few days after coming into view, to have broken into three or four parts of irregular figures. One observer compares them to so many burning coals; and says they changed their situation while he was looking at them, as when a person stirs a fire; and a few days after were broken into a great number of smaller pieces. Another account of the same is that on the 1st and 4th of December, the nucleus appeared to be a round, solid, and luminous body, of a dusky lead colour, larger than any star of the first magnitude. On the 8th of the same month it was broken into three or four parts of irregular figures; and on the 20th was changed into a cluster of small stars.

114 Phenomena of their tails.

"As the tail of a comet is owing to the heat of the sun, it grows larger as the comet approaches near to, and shortens as it recedes from, that luminary. If the tail of a comet were to continue of the same length, it would appear longer or shorter according to the different views of the spectator; for if his eye be in a line drawn through the middle of the tail lengthwise, or nearly so, the tail will not be distinguished from the rest of the atmosphere, but the whole will appear round; if the eye be a little out of that line, the tail will appear short as in fig. 83. and it is called a *bearded comet* when the tail hangs down towards the horizon, as in that figure. If the tail of a comet be viewed sideways, the whole length of it is seen. It is obvoius to remark, that the nearer the eye is to the tail, the greater will be the apparent length thereof.

"The tails of comets often appear bent, as in fig. 84 and 85, owing to the resistance of the æther; which, though extremely small, may have a sensible effect on so thin a vapour as the tails consists of. This bending is seen only when the earth is not in the plane of the orbit of the comet continued. When that plane passes thro' the eye of the spectator, the tail appears straight, as in fig. 86, 87.

"Longomontanus mentions a comet, that, in 1618, Dec. 10th, had a tail above 100 degrees in length; which shows that it must then have been very near the earth. The tail of a comet will at the same time appear of different length in different places, according as the air in one place is clearer than in another. It need not be mentioned, that in the same place, the difference in the eyes of their spectators will be the cause of their disagreeing in their estimate of the length of the tail of a comet.

115 Difference between the observations of Hevelius and Hooke.

"Hevelius is very particular in telling us, that he observed the comet of 1665 to cast a shadow upon the tail; for in the middle thereof there appeared a dark line. It is somewhat surprising, that Hooke should be positive in affirming, on the contrary, that the place where the shadow of that comet should have been, if there had been any shadow, was brighter that any other part of the tail. He was of opinion that comets have some light of their own. His observations were made in a hurry; he owns they were short and transitory: Hevelius's were made with so much care, that there is more reason to depend upon them. Dom. Cassini observed, in the tail of the comet of 1680, a darkness in the middle; and the like was taken notice of by a curious observer in that of 1744.

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"There are three comets, viz. of 1680, 1744, and 1759, that deserve to have a farther account given of them. The comet of 1680 was remarkable for its near approach to the sun; so near, that in its perihelion it was not above a sixth part of the diameter of that luminary from the surface thereof. Fig. 85, taken from Newton's Principia, represents so much of the trajectory of this comet as it passed through while it was visible to the inhabitants of our earth, in going from and returning to its perihelion. It shows also the tail as it appeared on the days mentioned in the figure. The tail, like that of other comets, increased in length and brightness as it came nearer to the sun; and grew shorter and fainter as it went farther from him and from the earth, till that and the comet were too far off to be any longer visible.

116 Account of the comet of 1680.

117 Of that of 1744.

"The comet of 1744 was first seen at Lausanne in Switzerland, Dec. 13th, 1743, N. S. From that time it increased in brightness and magnitude as it was coming nearer to the sun. The diameter of it, when at the distance of the sun from us, measured about one minute; which brings it out equal to three times the diameter of the earth. It came so near Mercury, that, if its attraction had been proportionable to its magnitude, it was thought probable it would have disturbed the motion of that planet. Mr Betts of Oxford, however, from some observations made there, and at Lord Macclesfield's observatory at Sherburn, found, that when the comet was at its least distance from Mercury, and almost twice as near the sun as that planet was, it was still distant from him a fifth part of the distance of the sun from the earth; and could therefore have no effect upon the planet's motions. He judged the comet to be at least equal in magnitude to the earth. He says, that in the evening of Jan. 23, this comet appeared exceedingly distinct and bright, and the diameter of its nucleus nearly equal to that of Jupiter. Its tail extended above 16 degrees from its body; and was in length, supposing the sun's parallax 10", no less than 23 millions of miles. Dr Bevis, in the month of May 1744, made four observations of Mercury, and found the places of that planet, calculated from correct tables, differed so little from the places observed, as to show that the comet had no influence upon Mercury's motion.

"The nucleus, which had before been always round, on the 10th of February appeared oblong in the direction of the tail, and seemed divided into two parts by a black stroke in the middle. One of the parts had a sort of beard brighter than the tail; this beard was surrounded by two unequal dark strokes, that separated the beard from the hair of the comet. The odd phenomena disappeared the next day, and nothing was seen but irregular obscure spaces like smoke in the middle of the tail; and the head resumed its natural form. Feb. 15th, the tail was divided into two branches; the eastern part about seven or eight degrees long, the western 24. On the 23d, the tail began to be bent; it showed no tail till it was as near to the sun as the orbit of Mars; the tail grew longer as it approached nearer the sun; and at its greatest length was computed to equal a third part of the distance of the earth from the sun. Fig. 84. is a view of this comet, taken by

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by an observer at Cambridge. I remember that in viewing it I thought the tail seemed to sparkle, or vibrate luminous particles. Hevelius mentions the like in other comets; and that their tails lengthen and shorten while we are viewing. This is probably owing to the motion of our air.

118 Of the comet of 1759.

"The comet of 1759 did not make any considerable appearance by reason of the unfavourable situation of the earth all the time, its tail might otherwise have been conspicuous; the comet being then too near the sun to be seen by us; but deserves our particular consideration, as it was the first that ever had its return foretold." See the following Section.

Hevelius gives pictures of comets of various shapes; as they are described by historians to have been like a sword, a buckle, a tun, &c. These are drawn by fancy only, from the description in words. He gives, however, also pictures of some comets, engraved by his own hand from the views he had of them through a very long and excellent telescope. In these we find changes in the nucleus and the atmosphere of the same comet. The nucleus of the comet of 1661, which in one observation appeared as one round body, as it is represented in fig. 87. in subsequent views seemed to consist of several smaller ones separated from one another, as in fig. 86. The atmosphere surrounding the nucleus, at different times, varied in the extent thereof; as did also the tail in length and breadth. The nuclei of other comets, as has already been observed, have sometimes phases like the moon. Those of 1744 and 1769 had both this kind of appearance. See fig. 34.

119 Number of fixed stars increased by telescopes.

10. The fixed stars, when viewed through the best telescopes, appear not at all magnified, but rather diminished in bulk; by reason, as is thought by some, that the telescope takes off that twinkling appearance they make to the naked eye; but by others more probably, that the telescopic tube excludes a quantity of the rays of light, which are not only emitted from the particular stars themselves, but by many thousands more, which falling upon our eye-lids and the aërial particles about us, are reflected into our eyes so strongly as to excite vibrations, not only on those points of the retina where the images of the stars are formed, but also in other points at the same distance round about. This without the telescope makes us imagine the stars to be much bigger than when we see them only by a few rays coming directly from them, so as to enter our eyes without being intermixed with others. The number of stars appears increased prodigiously through the telescope; 70 stars have been counted in the constellation called *Pleiades*, and no fewer than 2000 in that of Orion. The late improvements of Mr Herschel, however, have shown the number of stars to be exceedingly beyond even what the discoveries of former astronomers would induce us to suppose. He has also shown, that many which to the eye, or through ordinary glasses, appear single, do in fact consist of two or more stars; and that the galaxy or milky-way owes its light entirely to multitudes of small stars placed so close that the naked eye, or even ordinary telescopes, cannot discover them.

120 Of the nebulæ.

He has shown also, that the nebulæ, or small whitish specks, discoverable by telescopes in various parts of the heavens, are owing to the same cause. Former astronomers could only reckon 103; but Dr Herschel has discovered upwards of 1250. He has also discovered a species of them, which he calls *planetary nebulæ*, on account of their brightness and shining with a well-defined disk, being also capable of being magnified more than the fixed stars.

Conclusions from the foregoing Appearances.

Sect. III. *Conclusions from the foregoing Appearances.*

The conjectures which have been formed concerning the nature of the celestial bodies are so numerous, that a recital of them would fill a volume; while at the same time many of them are so ridiculous, that absurdity itself would seem almost to have been exhausted on this subject.

121 Opinions of the ancients concerning the sun.

1. As a specimen of what were the opinions of the ancient philosophers concerning the nature of the sun, it may suffice to mention that Anaximander and Anaximenes held, that there was a circle of fire all along the heavens, which they called *the circle of the sun*; between the earth and this fiery circle was placed another circle of some opaque matter, in which there was a hole like the mouth of a German flute. Through this hole the light was transmitted, and appeared to the inhabitants of this earth as a round and distinct body of fire. The eclipses of the sun were occasioned by stopping this hole.

We must not, however, imagine, that the opinions of all the ancients were equally absurd with those of Anaximander and Anaximenes. Many of them had more just notions, though very imperfect and obscure. Anaxagoras held the sun to be a fiery globe of some solid substance, bigger than Peloponnesus; and many of the moderns have adopted this notion, only increasing the magnitude of the globe prodigiously. Sir Isaac Newton has proposed it as a query, Whether the sun and fixed stars are not great *Earths* made vehemently hot, whose parts are kept from fuming away by the vast weight and density of their superincumbent atmospheres, and whose heat is preserved by the prodigious action and reaction of their parts upon one another? But though Sir Isaac has proposed this as a query and taken the existence of a solar atmosphere for granted, there have yet been no proofs adduced in favour of that opinion besides those of analogy and probability.

122 Of Sir Isaac Newton.

123 Of the existence of a solar atmosphere.

There is however, an appearance in the heavens termed the *semita luminosa*, or *zodiacal light*, which is now generally supposed to be owing to the sun's atmosphere. This was first discovered by Dom. Cassini in 1683. It is something like the milky-way, a faint twilight, or the tail of a comet, thin enough to let stars be seen through it, and seems to surround the sun in the form of a lens, the plane whereof is nearly coincident with that of the sun's equator. It is seen stretched along the zodiac, and accompanies the sun in his annual motion through the twelve signs. Each end terminates in an angle of about 21°: the extent of it in length from either of the angular points varies from 50 to 100°; it reaches beyond the orbit of Venus, but not so far as that of the earth. The breadth of it near the horizon is also various; from 12 almost to 30°: near the sun, where it may reasonably be supposed to be broadest, it cannot be seen. This light is weakest in the morning and strongest at night; disappearing in full

124 Semita luminosa, or zodiacal light.

Conclusions from the foregoing Appearances.

moonlight or in ſtrong twilight, and therefore is not at all viſible about midſummer in places ſo near either of the poles as to have their twilight all the night long, but may be ſeen in thoſe places in the middle of winter both morning and evening, as it may in places under and near the equator all the year round. In north latitude it is moſt conſpicuous after the evening twilight about the latter end of February, and before the morning twilight in the beginning of October; for at thoſe times it ſtands moſt erect above the horizon, and is therefore cleareſt from the thick vapours of the twilight. Beſides the difference of real extenſion of this light in length and breadth at different times, it is diminiſhed by the nearneſs of any other light in the ſky; not to mention that the extent of it will be differently determined by different ſpectators according to the goodneſs of their eyes.

125 Caſſini's explanation of this phenomenon.

Caſſini inquiring into the cauſe of this light, ſays firſt, that it might be owing to a great number of ſmall planets ſurrounding the ſun within the orbit of Venus; but ſoon rejects this for what he thinks a more probable ſolution, viz. that as by the rotation of the ſun ſome groſs parts are thrown up on his ſurface, whereof ſpots and nebuloſities are formed; ſo the great rapidity wherewith the equatorial parts are moved, may throw out to a conſiderable diſtance a number of particles of a much finer texture, of ſufficient denſity to reflect light: now, that this light was cauſed by an emanation from the ſun, ſimilar to that of the ſpots, he thought probable from the following obſervation: That after the year 1688, when this light began to grow weaker, no ſpots appeared upon the ſun; whereas, in the preceding years, they were frequently ſeen there; and that the great inequality in the intervals between the times of the appearances of the ſolar ſpots has ſome analogy to the irregular returns of weakneſs and ſtrength in this light, in like circumſtances of the conſtitution of the air, and of the darkneſs of the ſky. Caſſini was of opinion that this light in the zodiac, as it is ſubject to great increaſe at one time and diminution at another, may ſometimes become quite imperceptible; and thought this was the caſe in the years 1665, 1672, and 1681, when he ſaw nothing of it, though he ſurveyed with great attention thoſe parts of the heaven where, according to his theory, it muſt have appeared if it had been as viſible then as it was in others. He cites alſo paſſages out of ſeveral authors both ancient and modern, which make it probable that it had been ſeen both in former and latter ages, but without being ſufficiently attended to, or its nature inquired into. It had been taken for the tail of a comet, part of the twilight, or a meteor of ſhort continuance; and he was fully convinced of its having appeared formerly, from a paſſage in an Engliſh book of Mr Childrey's, printed in 1661. This paſſage is as follows:

126 Suppoſes ſome analogy between the ſolar ſpots and zodiacal light.

"There is ſomething more that we would recommend to the obſervation of the mathematicians; namely, that in the month of February, and a little before and after it (as I have obſerved for ſeveral years), about ſix o'clock in the evening, when the twilight has entirely left the horizon, a path of light tending from the twilight towards the Pleiades, and touching them as it were, preſented itſelf very plainly to my view. This path is to be ſeen when the weather is clear, but beſt of all when the moon does not ſhine." The ſame appearance is taken notice of in Gregory's Aſtronomy, and there expreſsly attributed to the ſun's atmoſphere.

Conclusions from the foregoing Appearances.

With regard to the ſolar ſpots, Dr Long informs us, that "they do not change their places upon the ſun, but adhere to his ſurface, or float in his atmoſphere, very near his body; and if there be 20 ſpots or faculæ upon him at a time, they all keep in the ſame ſituation with reſpect to one another; and, as long as they laſt are carried round together in the ſame manner: by the motion of the ſpots therefore we learn what we ſhould not otherwiſe have known, that *the ſun is a globe, and has a rotation* about his axis." Notwithſtanding this he tells us afterwards, "The ſpots, generally ſpeaking, may be ſaid to adhere to the ſun, or to be ſo near him as to be carried round upon him uniformly; nevertheleſs, ſometimes, though rarely, a ſpot has been ſeen to move with a velocity a little different from the reſt; ſpots that were in different parallels have appeared to be carried along, not keeping always the ſame diſtance, but approaching nearer to each other; and when two ſpots moved in the ſame parallel, the hindmoſt has been obſerved to overtake and paſs by the other. The revolution of ſpots near the equator of the ſun is ſhorter than of thoſe that are more diſtant from it."

127 Dr Long's opinion of the ſolar ſpots.

128 Of the ſun's revolution on his axis.

The apparent change of ſhape in the ſpots, as they approach the circumference of the diſk, according to our author, is likewiſe a proof of the ſun's rotation round his axis, and that they either adhere to the ſurface of the luminary, or are carried round his atmoſphere very near his ſurface.

"The rotation of the ſun (ſays Dr Long) being known, we may conſider his axis and poles, and their ſituation, as alſo his equator, or a circle imagined to be drawn upon that luminous globe equally diſtant from his poles; we may alſo imagine leſſer circles drawn thereon, parallel to his equator.

"The rotation of the ſun is according to the order of the ſigns; that is, any point on the ſurface of that vaſt globe turns round ſo as to look ſucceſſively at Aries, Taurus, Gemini, &c. which is alſo the way that all the primary planets are carried round him, though each of them in a plane a little different from that of the reſt. We muſt likewiſe obſerve, that the plane of the ſun's equator produced does not coincide with the heliocentric orbit of any of the planets, but cuts every one of them at a ſmall angle; it is neareſt to coincidence with the orbit of Venus.

"The ſun being a globe at a great diſtance from us, we always ſee nearly one-half of that globe at a time; but the viſible half is continually changing, by the rotation of the ſun, and the revolution of the earth in her orbit. To ſpeak accurately, we do not ſee quite half the ſun's globe at a time, we want ſo much of it as the ſun's apparent diameter amounts to; which, at his mean diſtance, is about 32 minutes; ſo much is the diameter of the inviſible part of the ſun greater than that of the viſible part: for this reaſon a ſpot may be about two hours longer inviſible than viſible.

129 Viſible part of the ſun's globe leſs than the inviſible.

"The time between the entrance of a ſpot upon the diſk and its exit therefrom, gives us nearly half the apparent period of the ſun's rotation, which is uſually in about 13 days; a ſpot that, after paſſing the diſk and diſappearing, returns again, gives the whole time,

Conclusions from the foregoing Appearances.

time, but not with preciſion; becauſe the ſpot may perhaps not keep all the while exactly in the ſame place, but have ſome floating motion of its own upon the ſurface of the ſun. Dom. Caſſini, taking notice that ſeveral ſpots had often appeared in the ſame parallel, thought that ſome particular places of the ſun might be more diſpoſed than others to ſupply the matter of theſe ſpots; and if ſo, that they would not move far from the place of their origin, juſt as the ſmoke of mount Ætna, if it could be ſeen from the ſun, would appear always to return to the ſame place of the diſk of the earth once every 24 hours, very nearly; ſometimes a little ſooner, ſometimes a little later, according as the ſmoke was driven by the wind from the place of its eruption. In conſequence of this ſuppoſition, he compared ſeveral large intervals between the appearances of ſpots carried in the ſame parallel, which he judged to be returns of the ſame ſpots ariſing out of the ſame place on the ſurface of the ſun, and found that 27 days 22 hours and 20 ſeconds was a common meaſure of thoſe intervals very nearly; this, therefore, he thought the moſt proper period to be taken for an apparent revolution of the ſolar ſpots, and conſequently of the ſun himſelf as ſeen from the earth. Theſe obſervations were made in April and May, nearly in the ſame time of the year, and therefore are not much affected by the inequality of the earth's motion. The ſame period is confirmed by Dom. Caſſini.

130 How to find the true time of a revolution of the ſpots.

The time of the apparent revolution of a ſpot being known, the true time of its going round upon the ſun may be thus found: In fig. 3. the arc AC, which in the month of May, the earth goes through in her orbit in 27 days 12 hours and 20 minutes, is 26° 22′; the arc *a c* being equal to AC: the apparent revolution of a ſpot is the whole circle *a b c d*, or 360°, with the addition of the arc *a c* of 26° 22′, which makes 386° 22′: then ſay, as 386.22 is to 27 d. 12 h. 20′; ſo is 360° to 25 d. 15 h. 16′; the true time of the rotation of the ſun, as it would be ſeen from a fixed ſtar.

Fig. 3.

The angle of interſection of the ſun's equator with the ecliptic is but ſmall, according to Scheiner being never more than 8°, nor leſs than 6°; for which reaſon he ſettled it at 7°, though Caſſini makes it 7¼.

131 Sun's nodes and limits.

This plane continued cuts the ecliptic in two oppoſite points, which are called the *ſun's nodes*, being 8° of ♋ and 8° of ♑; and two points in the ecliptic, 90° from the nodes, may be called the *limits*. Theſe are 8° of ♈ and 8° of ♎. When the earth is in either of theſe nodes, the equator of the ſun, if viſible, would appear as a ſtraight line; and, by reaſon of the vaſt diſtance of the ſun from us, all his parallels would likewiſe appear as ſtraight lines; but in every other ſituation of the earth, the equator and parallels of the ſun would, if viſible, appear as ellipſes growing wider the farther the earth is from the nodes, and wideſt of all when the earth is in one of her limits.

"In the preſent age (ſays Dr Long), on the 18th, of May, the earth is in the 8° of ♑, one of the nodes of the ſun, and conſequently the ſun's equator and parallels, if viſible, would appear as ſtraight lines, fig. 92. From that time the ſun's equator, and every parallel, begin to appear as half of an ellipſis convex, or ſwelling towards the ſouth, and growing wider every day to the 20th of Auguſt, where it is at the wideſt, as in fig. 93, the earth being then in the 8° of ♈, one of the limits. Immediately after, the apparent curvature of the ſun's equator and parallels continually decreaſes to the 19th of November, when they again appear as ſtraight lines, the earth being then in the other node. From that time the equator of the ſun and parallels become elliptical, convex towards the north; their curvature continually increaſing to the 15th of February, when the earth is arrived at the other limit; and their curvature then decreaſes continually to the 18th of May, when they again appear as ſtraight lines. Every ſpot is carried round the ſun in his equator, or in a parallel; therefore the apparent motion of the ſpots upon the ſun is rectilinear every year in May and November, at all other times elliptical." See fig. 16, 17. where the paths of ſome ſolar ſpots are delineated by Mr Dunn, in a manner ſeemingly inconſiſtent with what is juſt now delivered from Dr Long. From a farther conſideration of the nature of the paths deſcribed by the ſolar ſpots, the Doctor concludes that their appearance may be retarded about four hours by the unequal motion of the earth in its orbit.

Conclusions from the foregoing Appearances.

132 Of the nature and formation of the ſolar ſpots.

The nature and formation of the ſolar ſpots have been the ſubject of much ſpeculation and conjecture. Some have thought that the ſun is an opaque body, mountainous and uneven, as our earth is, covered all over with a fiery and luminous fluid; that this fluid is ſubject to ebbing and flowing, after the manner of our tides, ſo as ſometimes to leave uncovered the tops of rocks or hills, which appear like black ſpots; and that the nebuloſities about them are cauſed by a kind of froth. Others have imagined, that the fluid which ſends us ſo much light and heat, contains a nucleus or ſolid globe, wherein are ſeveral volcanoes, that, like Ætna or Veſuvius, from time to time caſt up quantities of bituminous matter to the ſurface of the ſun, and form thoſe ſpots which are ſeen thereon; and that as this matter is gradually conſumed by the luminous fluid, the ſpots diſappear for a time, but are ſeen to riſe again in the ſame places when thoſe volcanoes caſt up new matter. A third opinion is, that the ſun conſiſts of a fiery luminous fluid, wherein are immerſed ſeveral opaque bodies of irregular ſhapes; and that theſe bodies, by the rapid motion of the ſun, are ſometimes buoyed or raiſed up to the ſurface, where they form the appearance of ſpots, which ſeem to change their ſhapes according as different ſides of them are preſented to the view. A fourth opinion is, that the ſun conſiſts of a fluid in continual agitation; that, by the rapid motion of this fluid, ſome parts more groſs than the reſt are carried up to the ſurface of the luminary, like the ſcum of melted metal riſing up to the top in a furnace: that theſe ſcums, as they are differently agitated by the motion of the fluid, form themſelves into thoſe ſpots we ſee on the ſolar diſk; and, beſides the optical changes already mentioned, grow larger, are diminiſhed in their apparent magnitude, recede a little from, or approach nearer to, each other, and are at laſt entirely diſſipated by the continual rapid motion of the fluid, or are otherwiſe conſumed or abſorbed.

133 Spots of the ſun ſuppoſed by Dr Wilſon to be hollows.

In the 64th volume of the Philoſophical Tranſactions, Dr Wilſon advances a new opinion concerning the ſolar ſpots, viz. that they are hollows in the ſurface of the luminary. "All the foregoing appearances (ſays he), when taken together, and when duly conſidered, ſeem to prove in the moſt convincing manner, that

Conclusions from the foregoing Appearances.

that the nucleus of this ſpot (December 1762) was conſiderably beneath the level of the ſun's ſpherical ſurface.

"The next thing which I took into conſideration was, to think of ſome means whereby I could form an eſtimate of its depth. At the time of the obſervation I had, on December 12th, remarked that the breadth of the ſide of the umbra next the limb was about 14"; but, for determining the point in queſtion, it was alſo requiſite to know the inclination of the ſhelving ſide of the umbra to the ſun's ſpherical ſurface. And here it occurred, that, in the caſe of a large ſpot, this would in ſome meaſure be deduced from obſervation. For, at the time when the ſide of the umbra is juſt hid, or begins firſt to come in view, it is evident, that a line joining the eye and its obſerved edge, or uppermoſt limit, coincides with the plane of its declivity. By meaſuring therefore the diſtance of the edge from the limb, when this change takes place, and by repreſenting it by a projection, the inclination or declivity may in ſome meaſure be aſcertained. For in fig. 27, let ILDK be a portion of the ſun's limb, and A B C D a ſection of the ſpot, S L the ſun's ſemidiameter, L G the obſerved diſtance from the limb, when the ſide of the umbra changes; then will the plane of the umbra C D coincide with the line E D G drawn perpendicular to S L at the point G. Let F H be a tangent to the limb at the point D, and join S D.

134 His method of meaſuring their depth.

"Since G L, the verſed ſine of the angle L S D, is given by obſervation, that angle is given, which by the figure is equal to F D E or G D H; which angle is therefore given, and is the angle of inclination of the plane of the umbra to the ſun's ſpherical ſurface. In the ſmall triangle therefore C M D, which may be conſidered as rectangular, the angle M D C is given, and the ſide D C equal to A B is given nearly by obſervation; therefore the ſide M C is given, which may be regarded as the depth of the nucleus without any material error.

"I had not an opportunity, in the courſe of the foregoing obſervations, to meaſure the diſtance G L, not having ſeen the ſpot at the time when either of the ſides of the umbra changed. It is, however, certain, that when the ſpot came upon the diſk for the ſecond time, this change happened ſome time in the night between the 11th and 12th of December, and I judge that the diſtance of the plane of the umbra, when in a line with the eye, muſt have been about 1' 55" from the ſun's eaſtern limb; from which we may ſafely conclude, that the nucleus of the ſpot was, at that time, not leſs than a ſemidiameter of the earth below the level of the ſun's ſpherical ſurface, and made the bottom of an amazing cavity, from the ſurface downwards, whoſe other dimenſions were of much greater extent."

135 His conjectures concerning the nature of the ſun.

Having thus demonſtrated that the ſolar ſpots are vaſt cavities in the ſun, the Doctor next proceeds to offer ſome queries and conjectures concerning the nature of the ſun himſelf, and to anſwer ſome objections to his hypotheſis. He begins with aſking, Whether it is not reaſonable to think, that the vaſt body of the ſun is made up of two kinds of matter very different in their qualities; that by far the greateſt part is ſolid and dark; and that this dark globe is encompaſſed with a thin covering of that reſplendent ſubſtance, from which the ſun would ſeem to derive the whole of his vivifying heat and energy?—This, if granted, will afford a ſatisfactory ſolution of the appearance of ſpots; becauſe, if any part of this reſplendent ſurface ſhall be by any means diſplaced, the dark globe muſt neceſſarily appear; the bottom of the cavity correſponding to the nucleus, and the ſhelving ſides to the umbra. The ſhining ſubſtance, he thinks, may be diſplaced by the action of ſome elaſtic vapour generated within the ſubſtance of the dark globe. This vapour, ſwelling into ſuch a volume as to reach up to the ſurface of the luminous matter, would thereby throw it aſide in all directions: and as we cannot expect any regularity in the production of ſuch a vapour, the irregular appearance and diſappearance of the ſpots is by that means accounted for; as the reflux of the luminous matter muſt always occaſion the dark nucleus gradually to decreaſe, till at laſt it becomes indiſtinguiſhable from the reſt of the ſurface.

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Here an objection occurs, viz. That, on this ſuppoſition, the nucleus of a ſpot whilſt on the decreaſe ſhould always appear nearly circular, by the gradual deſcent of the luminous matter from all ſides to cover it. But to this the Doctor replies, that in all probability the ſurface of the dark globe is very uneven and mountainous, which prevents the regular reflux of the ſhining matter. This, he thinks, is rendered very probable by the enormous mountains and cavities which are obſerved in the moon; and why, ſays he, may there not be the ſame on the ſurface of the ſun? He thinks his hypotheſis alſo confirmed by the dividing of the nucleus into ſeveral parts, which might ariſe from the luminous matter flowing in different channels in the bottom of the hollow.—The appearance of the umbra after the nucleus is gone, he thinks, may be owing to a cavity remaining in the luminous matter, tho' the dark globe is entirely covered.

As to a motion of the ſpots, diſtinct from what they are ſuppoſed to receive from the rotation of the ſun round his axis, he ſays he never could obſerve any, except what might be attributed to the enlargement or diminution of them when in the neighbourhood of one another. "But (ſays he) what would farther contribute towards forming a judgment of this kind is, the apparent alteration of the relative place, which muſt ariſe from the motion acroſs the diſk on a ſpherical ſurface; a circumſtance which I am uncertain if it has been ſufficiently attended to."

The above mentioned hypotheſis, the Doctor thinks, is further confirmed by the diſappearance of the umbræ on the ſides of the ſpots contiguous to one another; as the action of the elaſtic vapour muſt neceſſarily drive the luminous matter away from each, and thus as it were accumulate it between them, ſo that no umbra can be perceived. As to the luminous matter itſelf, he conjectures, that it cannot be any very ponderous fluid, but that it rather reſembles a denſe fog which broods on the ſurface of the ſun's dark body. His general concluſion we ſhall give in his own words.

"According to the view of things given in the foregoing queries, there would ſeem to be ſomething very extraordinary in the dark and unignited ſtate of the great internal globe of the ſun. Does not this ſeem to indicate that the luminous matter that encompaſſes it derives not its ſplendor from any intenſity of heat? For, if this were the caſe, would not the parts underneath,

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neath, which would be perpetually in contact with that glowing matter, be heated to such a degree as to become luminous and bright? At the same time it must be confessed, that although the internal globe was in reality much ignited, yet when any part of it forming the nucleus of a spot is exposed to our view, and is seen in competition with a substance of such amazing splendor, it is no wonder that an inferior degree of light should, in these cases, be unperceivable.

136 Experiment proposed in order to confirm his hypothesis.

"In order to obtain some knowledge of this point, I think an experiment might be tried, if we had an opportunity of a very large spot, by making a contrivance in the eye-piece of a telescope, whereby an observer could look at the nuclues alone with the naked eye, without being in danger of light coming from any other part of the sun. In this case, if the observer found no greater splendor than what might be expected from a planet very near the sun, and illumined by as much of his surface as corresponds to the spot's umbra, we might reasonably conclude, that the solar matter, at the depth of the nucleus, is in reality not ignited. But from the nature of the thing, doth there seem any necessity for thinking that there prevails such a raging and fervent heat as many have imagined? It is proper here to attend to the distinction between this shining matter of the sun and the rays of light which proceed from it. It may perhaps be thought, that the reaction of the rays upon the matter, at their emission, may be productive of a violent degree of heat. But whoever would urge this argument in favour of the sun being intensely heated, as arising from the nature of the thing, ought to consider that all polished bodies are less and less disposed to be heated by the action of the rays of light, in proportion as their surfaces are more polished, and as their powers of reflection are brought to a greater degree of perfection. And is there not a strong analogy betwixt the reaction of light upon matter in cases where it is reflected and in cases where it is emitted?"

To this account of the solar spots, some objections have been made, particularly by Mr Wollaston, in the Philosophical Transactions, and M. de la Lande in the Memoirs of the Academy of Sciences; and to these Dr Wilson replied in the Philosophical Transactions for 1783, to the following purpose.

137 The Doctor's reply to objections.

"First of all (says he) it has been urged, as an objection of great weight, that the absence of the umbra on one side, where spots are near the limb, is not always constant; and of this I was sufficiently aware, having stated three cases from my own observation, when I did not perceive this change to take place. The reverend Francis Wollaston is the only person who, in the Philosophical Transactions, has bestowed any remarks on my publication; and though he acknowledges that the umbra generally changes in the manner I have determined, yet he expresses a difficulty as to my conclusion, on account of this circumstance not obtaining universally. Under similar expressions, M. de la Lande produces from his own observations, which appear to have been long continued, only three cases of the same kind, and four more from the ancient observations of M. Cassini and De la Hire. In regard to these last, I am not sure if such obsolete ones ought to be referred to in a question of the present kind. These excellent observers, entertaining no thought that any thing of moment depended upon a nice attention to the form of the spots, might easily overlook less obvious circumstances, especially when they were found near the limb. We may add further, that even when they were so situated, they retain the umbra at both ends; and that whole side of it which lies farthest from the centre of the disk and these parts in the aggregate, they might sometimes mistake for the umbra as not deficient in any particular place. But, even admitting the anomaly we at present consider to be much more frequent than can be contended for, still such cases can only be brought as so many exceptions to the general law or uniformity of appearance, from which the condition of by far the greatest number of spots is most undeniably deduced. The utmost therefore that can be alleged is, that some few spots differ from all the rest, or from the multitude; and are not, like them, excavations in the sun. But notwithstanding these few instances where the umbra is not found to change, when we consider how perfectly all spots resemble one another in their most striking features, there naturally rises some presumption for all under that description we have given, partaking of one common nature; and for this only difference in the phenomena depending upon something, which does not necessarily imply a complete generical distinction. It comes therefore to be inquired, how far spots, which when near the middle of the disk appear equal and similar in all things, may yet differ from one another as excavations, or as possessing the third dimension of depth? and how far the peculiar circumstances by which they may disagree, can contribute to make some resist this change of the umbra when near the limb much more than others?

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"In order to this, suppose two spots which occupy a space upon the sun corresponding to the equal arches GD, fig. 94. and let GM, DM, be drawn so as to coincide with the plane of the excavation in such a case. The breadth of the nucleus being commonly equal to that of the surrounding umbra, if the base MD of the triangle GDM conceived rectilineal, be divided in L, so as ML : LD :: MD : DG; and if through L be drawn LS parallel to DG, then will DGSL be the section of two spots having this condition; and which, as to sense, would, when far away from the limb, be equal in all apparent measures; tho' very unequal in the third dimension HE, or depth of the nucleus SL, and also in the inclination DGM of their sides parallel to the spherical surface of the sun. Now it is manifest from the construction of the figure, that the distances AB, AK, from the limb A, when the sides GS of the umbra disappear, must depend very much on the latter of these two circumstances; and when, according as the angle of inclination, DGM is smaller, the respective spot will go nearer to the limb than the other before the side of the umbra GS vanishes. But these very exceptions to the general phenomena which we are at present examining are of this kind; and may perhaps, from what has been now shown, proceed wholly from the shallowness and the very gradual shelving of some few spots which break out in certain tracts of the sun's body, over which the luminous matter lies very thinly mantled.

"In order to avoid circumlocution, we may call that side of the umbra which lies nearest the limb the *nearest umbra*, and the side opposite the *farthest umbra*;

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and to enter more particularly into the conſideration now before us, let us ſuppoſe a ſpot of 40″ over all, with its nucleus and umbra equally broad; then will the depth of the nucleus, and the apparent breadth of the neareſt umbra, when the plane of the fartheſt comes to coincide with the viſual ray, be expreſſed as in the following examples, where the apparent ſemidiameter of the ſun is ſuppoſed to be 16′, and his parallax 8.5″.

	Fartheſt umbra ſuppoſed to vaniſh when diſtant from the limb.	Depth of nucleus in Engliſh miles and ſeconds.		Apparent breadth of neareſt umbra.
I.	1′ 0″	4.54″	2118	8.58
II.	0 30	3.09	1442	6.02
III.	0 15	2.09	975	4.13
IV.	0 8	1.44	672	2.87

"Now becauſe in every aſpect of a ſpot the real breadth of either the fartheſt or neareſt umbra muſt be to the projected or apparent breadth as radius to the ſine of the angle which this reſpective plane makes with the viſual ray, it follows, that at any time before the ſpot comes ſo near the limb as is expreſſed in the above examples, the apparent breadth of the neareſt and fartheſt umbra cannot differ ſo much as by the quantity there ſet down for the apparent breadth of the neareſt when the other is ſuppoſed to vaniſh. Regarding, therefore, the fartheſt and neareſt umbra of the ſpot in Caſe IV. as two neighbouring viſible objects which turn narrower by degrees as the ſpot goes towards the limb, we ſhould undoubtedly judge that they contract as to ſenſe alike; ſince, ſo long as the fartheſt could be perceived, the other cannot appear to exceed it by a quantity that we could diſtinguiſh; and by the time the former coincides with the viſual ray, the extreme nearneſs to the limb would prevent our forming any certain judgment of either.

"From this laſt example, therefore, it appears manifeſt, that a ſpot anſwering to the deſcription and conditions therein mentioned, or one a little more ſhallow, would approach the limb, and finally go off the diſk, without that peculiar change of the umbra on one ſide which is ſo obvious on common occaſions, notwithſtanding it were an excavation whoſe nucleus or bottom is ſo many miles below the level of the ſurface. In the four caſes above ſtated, the diſtance of the remoteſt part of the nucleus from the ſun's limb, when the viſual ray coming from it is juſt interrupted by the lip of the excavation, or, in other words, the diſtance of the nucleus from the limb when it was totally hid, was alſo computed. Theſe diſtances are as follows:

Caſe I.	-	16.93″	Caſe III.	-	4.70″
II.	-	8.90	IV.	-	2.70

And it is remarkable, from the two laſt, how very near the limb a ſhallow ſpot of not more than 40″ in diameter may come before the nucleus wholly diſappears."

After deſcribing the method in which theſe computations were made, the doctor proceeds thus: "Perhaps it may be urged, that very ſhallow ſpots ought always to be known from the reſt, and diſcover themſelves, by a ſurrounding umbra, very narrow, compared to the extent of the nucleus; but we know far too little of the qualities of the luminous matter, and of the proximate cauſes of the ſpots, to ſay any thing at all upon a point of this kind. The breadth of the umbra is, as aſſumed in the computations, about equal to that of the nucleus, though ſometimes it varies more or leſs; but how far theſe relative dimenſions indicate depth or ſhallowneſs muſt be expounded only by obſervation, and not by any vague and imperfect notions of the nature and conſtitution of the ſun.

Conclusions from the foregoing Appearances.

"The mention of a pit, or hollow or excavation ſeveral thouſands of miles deep, reaching to that extent down through a luminous matter to darker regions, is ready to ſtrike the imagination in a manner unfavourable to a juſt conception of the nature of the ſolar ſpots as now deſcribed. Upon firſt thoughts it may look ſtrange how the ſides and bottom of ſuch vaſt abyſſes can remain ſo very long in ſight, whilſt, by the ſun's rotation, they are made to preſent themſelves more and more obliquely to our view. But when it is conſidered how extremely inconſiderable their greateſt depth is compared to the diameter of the ſun, and how very wide and ſhelving they are, all difficulties of this ſort will be entirely removed." Unleſs, however, we duly attend to theſe proportions, our notions upon the ſubject muſt be very erroneous; and it ſeems the more neceſſary to offer this caution, as this very thing is inaccurately repreſented in fig. 9. belonging to the Memoir under view, and in a way that may lead to miſtakes. Inſtead of exhibiting a ſpot as depreſſed below the ſurface of the ſun one hundredth part of his ſemidiameter, the ſection of it is there determined by two lines drawn from the circumference, and meeting in a point at the prodigious diſtance of one-fifth of the ſemidiameter below. Any reader, therefore, who pleaſes, by turning to fig. 95. may ſee how very ſmall a portion of the ſun's body is made up of the luminous matter when ſuppoſed every where 3967 Engliſh miles deep. A is a ſection of a ſpot 50″ diameter, ſituated in the deepeſt part of this reſplendent ſubſtance.

"What has now been inſiſted on at ſo much length concerning the ſhallowneſs and more gradual ſhelving of ſome few ſpots, will alſo apply to another objection which Mr de la Lande views in a ſtrong light.

138 How a ſpot may appear to make an indentation on the ſun's limb.

"Here we find quoted the great ſpot in 1719, ſeen by M. Caſſini; and, for the ſecond time, that of June 1703, ſeen by M. de la Hire; both which, on their arrival at the limb, are ſaid to have made an indentation or dark notch in the diſk; and this phenomenon is mentioned as abſolutely incompatible with ſpots being below the ſurface.

"It is moſt true, that if we look for any thing like this when the plane which coincides with the external boundary of the ſpots paſſes through the eye, the way that M. de la Lande conſiders the matter, it muſt be very large indeed before the diſk could be perceived deficient by any dark ſegment. But may not a ſpot, even no larger than M. Caſſini's, conſidered as an excavation, make, in a manner very different from this, ſomething like a notch; for, by the way, this phenomenon is not in the *Mem. Acad.* nor any where elſe that I know of, deſcribed with any ſort of preciſion.—M. Caſſini's great ſpot, by which we underſtood the nucleus, was of 30″; and ſuppoſing the umbra equally broad, its diameter over all muſt have been 1′ 30″. It would therefore occupy an extent upon the ſun's ſurface of 5° 22′ fully. Now, ſuppoſe a circular ſpace of that ſize upon the ſun diſtinguiſhed from the ſurround-

ing

ASTRONOMY

Plate LXVI

Fig. 35

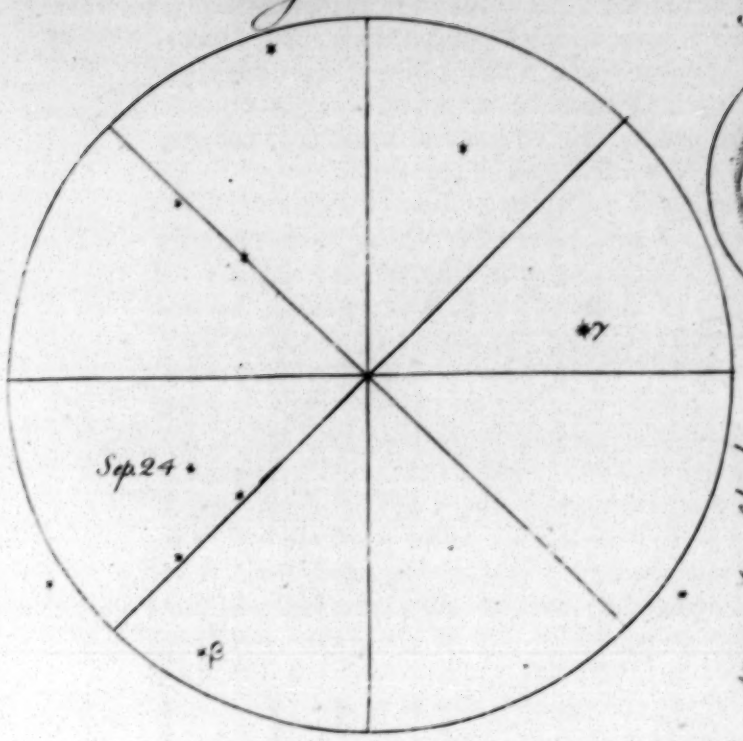


Fig. 37

Fig. 38

Fig. 39

Fig. 40

Fig. 41

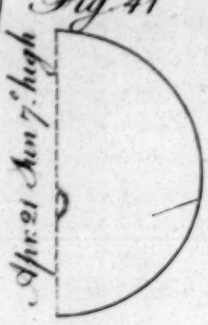


Fig. 42

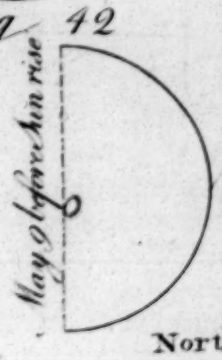


Fig. 43

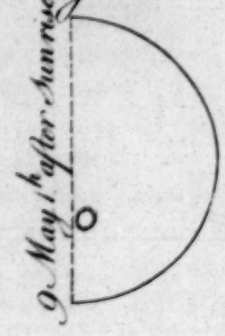
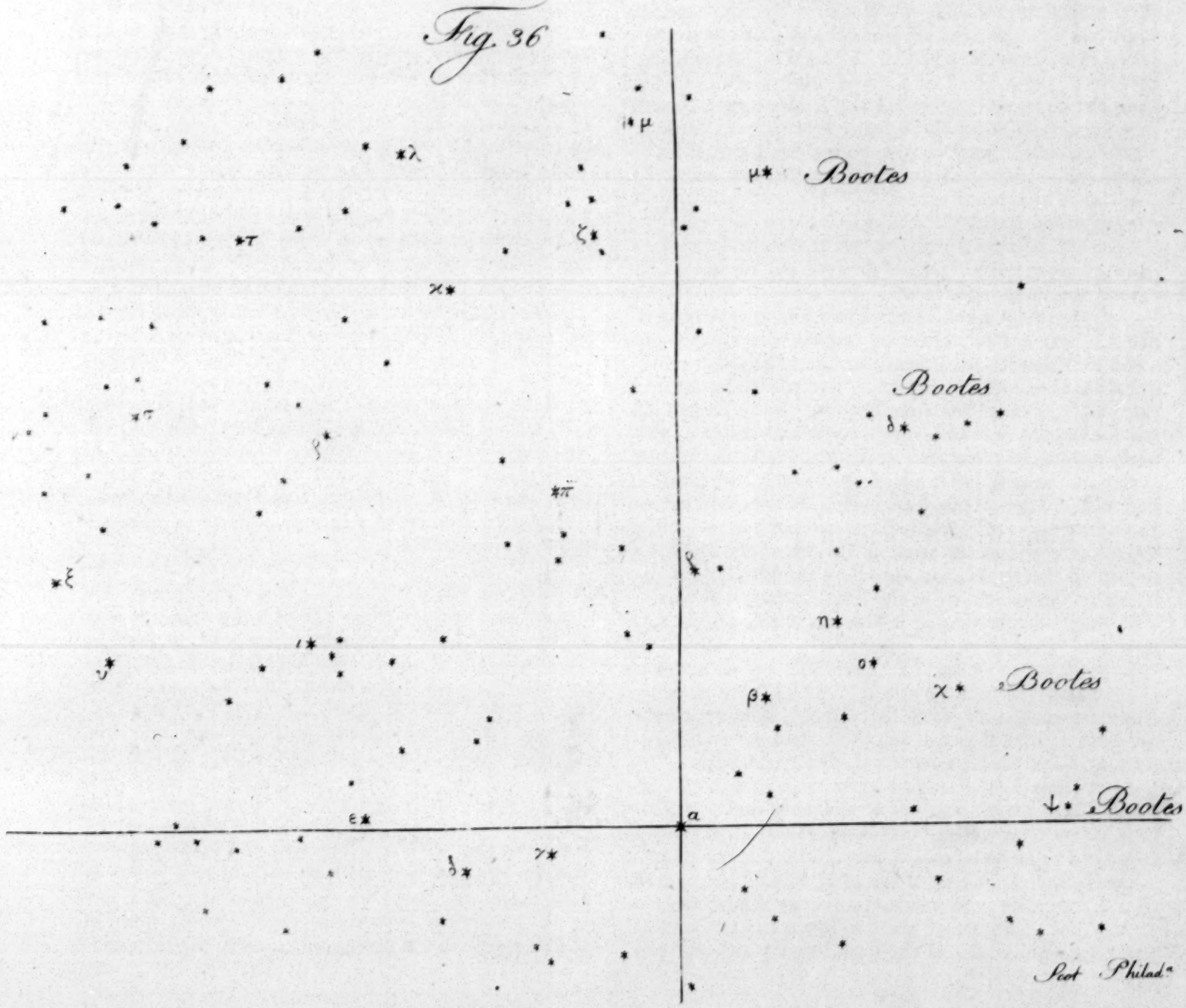


Fig. 44

Fig. 36



BRITISH MUSEUM

Concluſions from the foregoing Appearances.

ing luſtre by ſuch a failure of light as is peculiar to ſome ſpots, and ſuppoſe that it juſt touches the limb, it would ſtill ſubtend an angle of more than 4″. This being the caſe, might not a duſky ſhade, more or leſs remarkable according to the darkneſs of the umbra, commencing at the limb, and reaching inwards upon the diſk, or in other words, a notch be perceived? Had M. Caſſini's ſpot been a very ſhallow excavation, it appears by Caſe IV. that when viewed in this aſpect, ſome ſmall part of the nucleus might have yet been viſible; and might have contributed, along with the ſhade of the fartheſt umbra, and the ſtill broader and deeper ſhade of the two ends of the umbra, to mark out the indentation.

"Should it be ſaid, that theſe notches are always diſtinct and jet-black impreſſions on the diſk, of an obvious breadth, and originating entirely from the opaque nucleus conceived as ſomething prominent above the general ſurface, this can be ſhewn inconſiſtent with ſome circumſtances we find accidentally mentioned in the caſe of M. de la Hire's ſpot; for of this great one it was ſaid, that when only 8″ diſtant from the limb, the nucleus was ſeen as a very narrow line. This was on June 3d 1703, at ſix o'clock in the morning. Now, foraſmuch as at that time its alleged elevation muſt have been to its apparent ſubtenſe very nearly as radius to coſine of that arch of the ſun's circumference whoſe verſed ſine was the 8′ of diſtance from the limb, it is impoſſible that its breadth could have increaſed ſenſibly in its further progreſs towards the limb; and how any obvious black notch could be produced by the elevation contended for in this caſe is not conceivable.

"I do not imagine, therefore, that the phenomena of notches in the diſk, ſo inconſiderable and dubious as theſe ſeem to be, are by any means a proof of projecting nuclei, or that they are not reconcileable to ſpots being depreſſions on the ſun. A large ſhallow excavation, with the ſloping ſides or umbra darker than the common, may, as has been ſhown, be more or leſs perceptible at the limb; and what perhaps is a further confirmation of this, and ſeems to evince that ſuch a concurrence of circumſtances is neceſſary, is, that ſometimes even large ſpots make no indentation. M. Caſſini, in *Mem. Acad.* Tom X. p. 581. deſcribes the great ſpot of 1676, which he ſaw at its entrance with a teleſcope of 35 feet, as an obſcure line, parallel to the limb: but no where mentions that it made a notch in it.

"Though we now and then ſee the ſurrounding umbra darker than at other times; yet when ſpots are deep, and the umbræ but little duſky, it is indeed impoſſible that we ſhould ſee any thing of them, even though large, very near the limb: for here even the nucleus, which lies buried, cannot in the leaſt contribute to the effect, as it may do a little before its ſtate of evaneſcence, when ſpots are very ſhallow. Accordingly, caſes of this kind are perfectly agreeable to experience.

"In reaſoning concerning the nature of the ſpots, and particularly about their third dimenſion, the only arguments which are admiſſible, and which carry with them a perfect conviction, are thoſe grounded upon the principles of optical projection. If, for example, the far greater number of them be excavations ſome thouſands of miles deep, certain changes of the umbra would be obſervable when near the limb, as has been ſhown at ſo much length. Were they very ſhallow, or quite ſuperficial, both ſides of the umbra would as to ſenſe contract alike in their progreſs toward the limb; for if, in caſe 4th above ſtated, the ſpot had been ſuppoſed ſuperficial, the apparent breadth of the ſide of the umbra next the centre of the diſk would have made them only 1.62′, and that of the ſide oppoſite 1.27′. Now, the whole of either of theſe quantities, and much more their difference, would be quite inſenſible. Again, if the nucleus extended much above the common level, whilſt the ſurrounding umbra was ſuperficial, we ſhould behold the manifeſt indications of this by ſuch an opaque body when ſeen very obliquely being projected acroſs the fartheſt ſide of the umbra, and by hiding the whole or part of it before the time it would otherwiſe diſappear. According to this or that condition of the ſpot, ſuch things muſt infallibly obtain by the known laws of viſion; and hence arguments reſting upon ſuch principles may be denominated optical ones. On the other hand, when ſpots are contemplated near the middle of the diſk, a great variety of changes are obſerved in them, which depend not upon poſition, but upon certain phyſical cauſes producing real alterations in their form and dimenſions. It is plain, that arguments derived from the conſideration of ſuch changes, and which, on that account, may be called *phyſical arguments*, can aſſiſt us but little in inveſtigating their third dimenſions; and, from the nature of the thing, muſt be liable to great uncertainty. The author of the *Memoire*, in p. 511, &c. takes new ground, and proceeds with a number of objections depending upon that ſort of reaſoning which we have laſt defined. I muſt take notice, that a certain diſtinction has been here overlooked, which in my paper I have endeavoured to point out. Preſuming upon our great ignorance of many things which doubtleſs affect deeply the conſtitution of that wonderful body the ſun, I offered in part II. an account of the productions, changes, and decay of the ſpots, conſidered as excavations, in the moſt looſe and problematical manner; ſtating every thing on this head in the form of queries.—— Hence I would remark, that whatever inconſiſtencies are imagined in the account I have delivered Part II. though ſuch may be juſtly chargeable on certain principles there aſſumed, yet they ought not to be ſtated as preſumptions againſt the ſpots being really excavations or depreſſions in the luminous matter of the ſun. This opinion muſt reſt entirely upon the evidence held forth in the firſt part of the paper, whatever be the fate of the account laid down in the ſecond. It does not enter there as an *hypotheſis*, but as a matter of fact previouſly eſtabliſhed by *optical arguments*; and from optical arguments alone can there ariſe even any juſt preſumptions againſt it.

Concluſions from the foregoing Appearances.

139 Remarks on M. de la Lande's theory of the ſolar ſpots.

"It remains now only to make a few ſtrictures upon M. de la Lande's theory of the ſolar ſpots, humbly ſubmitting them to the conſideration of the reader. The import of it is, 'that the ſpots as phenomena ariſe from dark bodies like rocks, which by an alternate flux and reflux of the liquid igneous matter of the ſun, ſometimes raiſe their heads above the general ſurface. That part of the opaque rock, which at any time thus ſtands above, gives the appearance of the nucleus, whilſt thoſe parts,

Conclusions from the foregoing Appearances.

parts, which in each lie only a little under the igneous matter, appear to us as the ſurrounding umbra.'

"In the firſt place it may be remarked, that the whole proceeds upon mere ſuppoſition. This indeed the author himſelf very readily acknowledges. Though therefore it could not be diſputed by arguments derived from obſervation, yet conjecture of any kind, if equally plauſible, might fitly be employed to ſet aſide its credit. Without entering into any tedious diſcuſſion, however, we ſhall confine ourſelves to ſuch particulars as appertain to the more obvious characters of the ſpots, and which alſo ſeem to be irreconcileable with the theory; and firſt of all with regard to the diſtinguiſhing features of the umbra.

"M. Caſſini, Mem. Acad. tom. x. p. 582. Pl. VII. and M. de la Hire, Mem. Acad. 1703. p. 16. and I may add all other obſervers, and all good repreſentations of the ſpots, bear teſtimony to the exterior boundary of the umbra being always well defined, and to the umbra itſelf being leſs and leſs ſhady the nearer it comes to the nucleus. Now it may be aſked, how this could poſſibly be, according to M. de la Lande's theory? If the umbra be occaſioned by our ſeeing parts of the opaque rock which lie a little under the ſurface of the igneous matter, ſhould it not always be darkeſt next the nucleus? and, from the nucleus outward, ſhould it not wax more and more bright, and at laſt loſe itſelf in the general luſtre of the ſun's ſurface, and not terminate all at once in the darkeſt ſhade, as in fact it does? Theſe few incongruities, which meet as it were in the very threſhold of the theory, are ſo very palpable, that of themſelves they raiſe unſurmountable doubts. For, generally ſpeaking, the umbra immediately contiguous to the nucleus, inſtead of being very dark, as it ought to be, from our ſeeing the immerſed parts of the opaque rock through a thin ſtratum of the igneous matter, is on the contrary very nearly of the ſame ſplendor as the external ſurface.

"Concerning the nucleus, or that part of the opaque rock, which ſtands above the ſurface of the ſun, M. de la Lande produces no optical arguments in ſupport of this third dimenſion or height. Neither does he ſay any thing particular as to the degree of elevation above the ſurface. But from what has been already hinted in the courſe of this paper, it appears that if this were any thing ſenſible, it ought to be diſcovered by phenomena very oppoſite to thoſe which we have found to be ſo general.

"Again, a flux and reflux of the igneous matter, ſo conſiderable as ſometimes to produce a great number of ſpots all over the middle zone, might affect the apparent diameter of the ſun, making that which paſſes through his equator leſs than the polar one, by the retreat of the igneous matter towards thoſe regions where no ſpots ever appear. But as a difference of this kind, of nearly one thouſandth part of the whole would be perceivable, as we learn from M. de la Lande's own obſervations, compared with thoſe of Mr. Short in *Hiſtoire Acad.* 1760, p. 123. it would ſeem, that the theory had this difficulty alſo to combat. Further, when among ſpots very near one another ſome are obſerved to be increaſing whilſt others are diminiſhing, how is it poſſible this can be the effect of ſuch a ſuppoſed flux and reflux? This laſt inconſiſtency is mentioned by the author himſelf, who endeavours to avoid it by making a new demand upon the general fund of hypotheſis, deriving from thence ſuch qualities of the igneous matter as the caſe ſeems to require; and ſuch muſt be the method of proceeding in all ſyſtems merely theoretical. But it is unneceſſary to purſue at more length illuſive ſpeculations of this kind, eſpecially as we lie under a conviction founded on fact, of the theory being utterly erroneous. It hardly differs in any reſpect from that propoſed by M. de la Hire, and a little amended by the writer of the *Hiſtoire de l'Academie* for 1707, p. 111. Views very much of the ſame kind were even entertained by ſome ſo long ago as the days of Scheiner, as we find mentioned by that indefatigable author in his *Roſa Urſina*, p. 746."

Conclusions from the foregoing Appearances.

140 Great inequalities on the ſurface of the moon.

2. Concerning the moon, it is allowed on all hands, that there are prodigious inequalities on her ſurface. This is proved by looking at her through a teleſcope, at any other time than when ſhe is full; for then there is no regular line bounding light and darkneſs; but the confines of theſe parts appear as it were toothed and cut with innumerable notches and breaks; and even in the dark part, near the borders of the lucid ſurface, there are ſeen ſome ſmall ſpaces enlightened by the ſun's beams. Upon the fourth day after new moon, there may be perceived ſome ſhining points like rocks or ſmall iſlands within the dark body of the moon; but not far from the confines of light and darkneſs there are obſerved other little ſpaces which join to the enlightened ſurface, but run out into the dark ſide, which by degrees change their figure, till at laſt they come wholly within the illuminated face, and have no dark parts round them at all Afterwards many more ſhining ſpaces are obſerved to ariſe by degrees, and to appear within the dark ſide of the moon, which before they drew near to the confines of light and darkneſs were inviſible, being without any light, and totally immerſed in the ſhadow. The contrary is obſerved in the decreaſing phaſes, where the lucid ſpaces which joined the illuminated ſurface by degrees recede from it, and after they are quite ſeparated from the confines of light and darkneſs, remain for ſome time viſible, till at laſt they alſo diſappear. Now it is impoſſible that this ſhould be the caſe, unleſs theſe ſhining points were higher than the reſt of the ſurface, ſo that the light of the ſun may reach them.

141 Method of meaſuring the lunar mountains. Fig. 20.

Not content with perceiving the bare exiſtence of theſe lunar mountains, aſtronomers have endeavoured to meaſure their hight in the following manner. Let EGD be the hemiſphere of the moon illuminated by the ſun, ECD the diameter of the circle bounding light and darkneſs, and A the top of a hill within the dark part when it firſt begins to be illuminated. Obſerve with a teleſcope the proportion of the right line AE, or the diſtance of the point A from the lucid ſurface to the diameter of the moon ED; and becauſe in this caſe the ray of light ES touches the globe of the moon, AEC will be a right angle by 16 prop. of Euclid's third book; and therefore in the triangle AEC having the two ſides AE and EC, we can find out the third ſide AC; from which ſubducting BC or EC, there will remain AB the height of the mountain. Ricciolus affirms, that upon the fourth day after new moon he has obſerved the top of the hill called *St Catharine's* to be illuminated, and that it was diſtant from the confines of the lucid ſurface about a ſixteenth part of

Conclusions from the foregoing Appearances.

of the moon's diameter. Therefore, if CE=8, AE will be 1, and AC²=CE²+AE² by prop. 47. of Euclid's first book. Now the square of CE being 64, and the square of AE being 1, the square of AC will be 65, whose square root is 8,062, which expresses the length of AC. From which deducting BC=8, there will remain AB=0,062. So that CB or CE is therefore to AB as 8 is to 0,062, that is, as 8000 is to 62. If the diameter of the moon therefore was known, the height of this mountain would also be known. This demonstration is taken from Dr Keil, who supposes the semidiameter of the moon to be 1182 miles; according to which, the mountain must be somewhat more than nine miles of perpendicular height: but astronomer's having now determined the moon's semidiameter to be only 1090 miles, the height of the mountain will be nearly 8¼ miles.

142 Height of the lunar mountains over-rated.

In the former edition of this work, we could not help making some remarks on the improbability that the mountains of the moon, a planet so much inferior in size to the earth, should exceed in such vast proportion to the highest of our mountains, which are computed at little more than one-third of the height just mentioned. Our remark is now confirmed by the

143 Mr Herschel's observations on them.

observations of Mr Herschel. After explaining the method used by Galileo, Hevelius, &c. for measuring the lunar mountains, he tells us, that the former takes the distance of the top of a lunar mountain from the line that divides the illuminated part of the disk from that which is in the shade to be equal to one-twentieth of the moon's diameter; but Hevelius makes it only one-twenty-sixth. When we calculate the height of such a mountain, therefore, it will be found, according to Galileo, almost 5¼ miles; and according to Hevelius 3¼ miles, admitting the moon's diameter to be 2180 miles. Mr Ferguson, however, says, (Astronomy explained, § 252.), that some of her mountains, by comparing their height with her diameter, are found to be three times higher than the highest hills on earth; and Keil, in his Astronomical Lectures, has calculated the height of St. Catharine's hill, according to the observations of Ricciolus, and finds it nine miles. Having premised these accounts, Mr Herschel explains his method of taking the height of a lunar mountain from observations made when the moon was not in her quadrature as the method laid down by Hevelius answers only to that particular case: for in all others the projection must appear shorter than it really is. "Let SLM, says he, or *s l m*, (fig. 96.) be a line drawn from the sun to the mountain, touching the moon at L or *l*, and the mountain at M or *m*. Then, to an observer at E or *e*, the lines LM, *l m*, will not appear of the same length, though the mountains should be of an equal height; for LM will be projected into *o n*, and *l m* into ON. But these are the quantities that are taken by a micrometer when we observe a mountain to project from the line of illumination. From the observed quantity *o n*, when the moon is not in her quadrature, to find LM, we have the following analogy. The triangles *o* OL, *r* ML, are similar; therefore L*o* : LO :: L*r* : LM, or $\frac{LO \times o\,n}{L\,o} = LM$: but LO is the radius of the moon, and L*r* or *o n* is the observed distance of the mountain's projection; and L*o* is the sine of the angle ROL=*o* LS; which we may take to be the distance of the sun from the moon without any material error, and which therefore we may find at any given time from an ephemeris.

Conclusions from the foregoing Appearances.

"The telescope used in these observations was a Newtonian reflector of six feet eight inches focal length, to which a micrometer was adopted, consisting of two parallel hairs, one of which was moveable by means of a fine screw. The value of the parts shown by the index was determined by a trigonometrical observation of a known object at a known distance, and was verified by several trials. The power was always 222, excepting where another is expressly mentioned; and this was also determined by experiment which frequently differs from theory on account of some small errors in the data, hardly to be avoided. The moon having sufficient light, an aperture of no more than four inches was made use of; and, says Mr Herschel, "I believe, that, for distinctness of vision, this instrument is perhaps equal to any that ever was made."

With this instrument he observed a prominence, which he calls *a rock*, situated near the *Lacus Niger* of Hevelius, and found that it projected 41.56″. To reduce this into miles, put R for the semidiameter of the moon in seconds, as given by the nautical almanack at the time of observation, and Q for the observed quantity, also in seconds and centesimals; then it will be in general, R: 1090 :: Q : $\frac{1090Q}{R} = o\,n$ in miles. Thus it is found, that 41.56″ is 46.79 miles. The distance of the sun from the moon at that time was, by the nautical almanack, about 93° 57½′; the sine of which to the radius 1 is .9985, &c. and $\frac{o\,n}{L\,o}$ in this case is LM=46.85 miles. Then, by Hevelius's method, the perpendicular height of the rock is found to be about one mile. At the same time, a great many rocks, situated about the middle of the disk, projected from 25.92″ to 26.56″; which gives *o n* about 29.3 miles: so that these rocks are all less than half a mile high.

These observations were made on the 13th of November 1779. On the 13th of January 1780, examining the mountains of the moon, he found that there was not one of them fairly placed on level ground, which is very necessary for an exact measurement of the projection: for if there should be a declivity on the moon before the mountains, or a tract of hills placed so as to cast a shadow upon that part before them which would otherwise be illuminated, the projection would appear too large; and on the contrary, should there be a rising ground before them, it would appear too little.

Proceeding in this cautious manner, Mr Herschel measured the height of many of the lunar prominences, and draws at last the following conclusions.—"From these observations I believe it is evident, that the height of the lunar mountains in general is greatly over-rated; and that, when we have excepted a few, the generality do not exceed half a mile in their perpendicular elevation. It is not so easy to find any certain mountain exactly in the same situation it has been measured in before; therefore some little difference must be expected in these measures. Hitherto I have not had an opportunity of particularly observing the three mountains mentioned by Hevelius; nor that which

Concluſions from the foregoing Appearances.

which Ricciolus found to project a ſixteenth part of the moon's diameter. If Keill had calculated the height of this laſt mentioned hill according to the theorem I have given, he would have found (ſuppoſing his obſervation to have been made, as he ſays, on the fourth day after new moon) that its perpendicular height could not well be leſs than between 11 and 12 miles. I ſhall not fail to take the firſt opportunity of obſerving theſe four, and every other mountain of any eminence; and if other perſons, who are furniſhed with good teleſcopes and micrometers, would take the quantity of the projection of the lunar mountains, I make no doubt but that we ſhould be nearly as well acquainted with their heights, as we are with the elevation of our own.

144 Caution to be obſerved in uſing Dollond's teleſcopes.

One caution I would beg leave to mention to thoſe who may uſe the excellent 3¼ feet refractors of Mr Dollond. The admirable quantity of light, which on moſt occaſions is ſo deſirable, will probably give the meaſure of the projection ſomewhat larger than the true, if not guarded againſt by proper limitations placed before the object-glaſs. I have taken no notice of any allowance to be made for the refraction a ray of light muſt ſuffer in paſſing through the atmoſphere of the moon, when it illuminates the top of the mountain, whereby its apparent height will be leſſened, as we are too little acquainted with that atmoſphere to take it into conſideration. It is alſo to be obſerved, that this would equally affect the concluſions of Hevelius, and therefore the difference in our inferences would ſtill remain the ſame."

In the continuation of his obſervations Mr Herſchel informs us that he had meaſured the height of one of the mountains which had been meaſured by Hevelius. "Antitaurus (ſays he), the mountain meaſured by Hevelius, was badly ſituated; becauſe Mount Moſchus, and its neighbouring hills caſt a deep ſhadow which may be miſtaken for the natural convexity of the moon. A good, full, but juſt meaſure, 25.105″; in miles, 29.27: therefore LM 31.7 miles, and the perpendicular height not quite half a mile. As great exactneſs was deſired in this obſervation, it was repeated with very nearly the ſame reſult. Several other mountains were meaſured by the ſame method, and all his obſervations concurred in making the height of the lunar mountains much leſs than what former aſtronomers had done. Mount Lipulus was found to be near two-thirds of a mile; one of the Appenine mountains between Lacus Traſimenus and Pontus Euxinus meaſured a mile and a quarter; Mons Armenia, near Taurus, two-thirds of a mile; Mons Leucoptera three quarters of a mile. Mons Sacer projected 45.625″; 'but (ſays he) I am almoſt certain that there are two very conſiderable cavities or places where the ground deſcends below the level of the convexity, juſt before theſe mountains; ſo that theſe meaſures muſt of courſe be a good deal too large; but ſuppoſing them to be juſt, it follows, that *o n* is 50.193 miles, LM=64 miles, and the perpendicular height above 1¾ miles.'

145 Volcanoes diſcovered in the moon.

As the moon has on its ſurface mountains and valleys in common with the earth, ſome modern aſtronomers have diſcovered a ſtill greater ſimilarity, viz. that ſome of theſe are really volcanoes, emitting fire as thoſe on earth do. An appearance of this kind was diſcovered ſome years ago by Don Ulloa in an eclipſe of the ſun. It was a bright ſmall ſpot like a ſtar near the margin of the moon, and which he at that time ſuppoſed to have been a hole with the ſun's light ſhining through it. Succeeding obſervations, however, have induced aſtronomers to attribute appearances of this kind to the eruption of volcanic fire; and Mr Herſchel has particularly obſerved ſeveral eruptions of the lunar volcanoes, the laſt of which he gives an account of in the Phil. Tranſ. for 1787. "April 19. 10h. 36, ſidereal time. I perceive (ſays he) three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwiſe in a ſtate of going to break out; which perhaps may be decided next lunation. The third ſhows an actual eruption of fire or luminous matter. I meaſured the diſtance of the crater from the northern limb of the moon, and found it 3′ 57.3″: its light is much brighter than the nucleus of the comet which M. Mechain diſcovered at Paris the 10th of this month.

"April 20. 10 h. 2′ ſidereal time. The volcano burns with greater violence than laſt night. Its diameter cannot be leſs than 3″, by comparing it with that of the Georgian planet: as Jupiter was near at hand, I turned the teleſcope to his third ſatellite, and eſtimated the diameter of the burning part of the volcano to be equal to at leaſt twice that of the ſatellite; whence we may compute that the ſhining or burning matter muſt be above three miles in diameter. It is of an irregular round figure, and very ſharply defined on the edges. The other two volcanoes are much farther towards the centre of the moon, and reſemble large, pretty faint nebulæ, that are gradually much brighter in the middle; but no well-defined luminous ſpot can be diſcerned in them. Theſe three ſpots are plainly to be diſtinguiſhed from the reſt of the marks upon the moon; for the reflection of the ſun's rays from the earth is, in its preſent ſituation, ſufficiently bright, with a ten-feet reflector, to ſhow the moon's ſpots, even the darkeſt of them; nor did I perceive any ſimilar phenomena laſt lunation, though I then viewed the ſame places with the ſame inſtrument.

"The appearance of what I have called the *actual fire*, or eruption of a volcano, exactly reſembled a ſmall piece of burning charcoal when it is covered by a very thin coat of white aſhes, which frequently adhere to it when it has been ſome time ignited; and it had a degree of brightneſs about as ſtrong as that with which ſuch a coal would be ſeen to glow in faint daylight. All the adjacent part of the volcanic mountain ſeemed to be faintly illuminated by the eruption, and were gradually more obſcure as they lay at a greater diſtance from the crater. This eruption reſembled much that which I ſaw on the 4th of May in the year 1783, but differed conſiderably in magnitude and brightneſs; for the volcano of the year 1783, though much brighter than that which is now burning, was not near ſo large in the dimenſions of its eruption: the former ſeen in the teleſcope reſembled a ſtar of the fourth magnitude as it appears to the naked eye; this, on the contrary, ſhows a viſible diſk of luminous matter very different from the ſparkling brightneſs of ſtar-light."

146 Conjectures concerning her ſurface.

Concerning the nature of the moon's ſubſtance there have been many conjectures formed. Some have imagined,

Fig. 45.

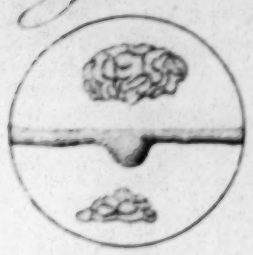


Fig. 46.

Fig. 47.

Fig. 48.

Fig. 49.

Fig. 50.

Fig. 51.

Fig. 52.

Fig. 53.

Fig. 54.

Fig. 55.

Fig. 56.

Fig. 57.

Fig. 58.

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Fig. 60.

Fig. 61.

Fig. 62.

Fig. 63.

Fig. 64.

Fig. 65.

Fig. 66.

Fig. 73.

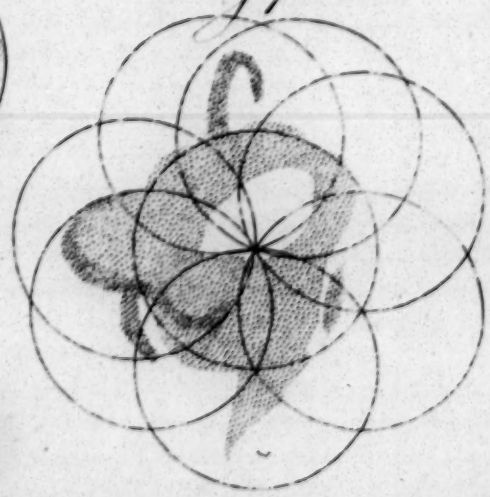


Fig. 67.

Fig. 68.

Fig. 69.

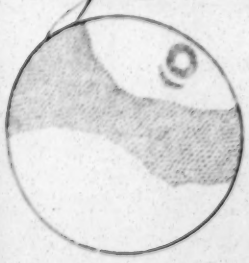


Fig. 70.

Fig. 71.

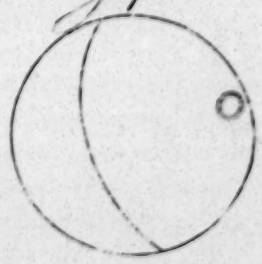
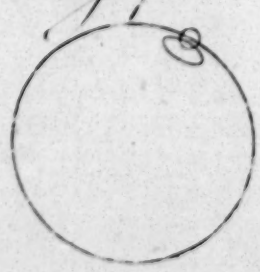


Fig. 72.



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gined, that, beſides the light reflected from the ſun, the moon hath alſo ſome obſcure light of her own, by which ſhe would be viſible without being illuminated by the ſun-beams. In proof of this it is urged, that during the time of even total eclipſes the moon is ſtill viſible, appearing of a dull red colour, as if obſcured by a great deal of ſmoke. In reply to this it hath been advanced, that this is not always the caſe; the moon ſometimes diſappearing totally in the time of an eclipſe, ſo as not to be diſcernable by the beſt glaſſes, while little ſtars of the fifth and ſixth magnitudes were diſtinctly ſeen as uſual. This phenomenon was obſerved by Kepler twice, in the years 1580 and 1583; and by Hevelius in 1620. Ricciolus and other Jeſuits at Bologna, and many people throughout Holland, obſerved the ſame on April 14, 1642; yet at Venice and Vienna ſhe was all the time conſpicuous. In the year 1703, Dec. 23, there was another total obſcuration. At Arles, ſhe appeared of a yellowiſh brown; at Avignon, ruddy and tranſparent, as if the ſun had ſhone through her: at Marſeilles, one part was reddiſh and the other very duſky; and at length, though in a clear ſky, ſhe totally diſappeared. The general reaſon for her appearance at all during the time of eclipſes ſhall be given afterwards: but as for theſe particular phenomena, they have not yet, as far as we know, been ſatisfactorily accounted for.

Different conjectures have alſo been formed concerning the ſpots on the moon's ſurface. Some philoſophers have been ſo taken with the beauty of the brighteſt places obſerved in her diſk, that they have imagined them to be rocks of diamonds; and others have compared them to pearls and precious ſtones. Dr Keill and the greateſt part of aſtronomers now are of opinion, that thoſe are only the tops of mountains which by reaſon of their elevation are more capable of reflecting the ſun's light than others which are lower. The duſkiſh ſpots, he ſays, cannot be ſeas, nor any thing of a liquid ſubſtance; becauſe, when examined by the teleſcope, they appear to conſiſt of an infinity of caverns and empty pits, whoſe ſhadows fall within them, which can never be the caſe with ſeas, or any liquid ſubſtance: but, even within theſe ſpots, brighter places are alſo to be obſerved; which, according to his hypotheſis, ought to be the points of rocks ſtanding up within the cavities. Dr Long, however, is of opinion that ſeveral of the dark ſpots on the moon are really water. May not the lunar ſeas and lakes (ſays he) have iſlands in them, wherein there may be pits and caverns? And if ſome of theſe dark parts be brighter than others, may not that be owing to the ſeas and lakes being of different depths, and to their having rocks in ſome places and flats in others?

It has alſo been urged, that if all the dark ſpots obſerved on the moon's ſurface were really the ſhadows of mountains, or of the ſides of deep pits, they could not poſſibly be ſo permanent as they are found to be; but would vary according to the poſition of the moon with regard to the ſun, as we find ſhadows on earth are varied according as the earth is turned towards or from the ſun. Accordingly it is pretended, that variable ſpots are actually diſcovered on the moon's diſk, and that the direction of theſe is always oppoſite to the ſun. Hence they are found among thoſe parts which are ſooneſt illuminated in the increaſing moon, and in the decreaſing moon loſe their light ſooner than the intermediate ones; running round, and appearing ſometimes longer, and ſometimes ſhorter. The permanent dark ſpots, therefore, it is ſaid, muſt be ſome matter which is not fitted for reflecting the rays of the ſun ſo much as the bright parts do; and this property, we know by experience, belongs to water rather than land: whence theſe philoſophers conclude, that the moon, as well as our earth, is made up of land and ſeas.

Concluſions from the foregoing Appearances.

147 Whether the moon has any atmoſphere.

It has been a matter of diſpute whether the moon has any atmoſphere or not. The following arguments have been urged by thoſe who take the negative ſide.

1. The moon conſtantly appears with the ſame brightneſs when there are no clouds in our atmoſphere; which could not be the caſe if ſhe were ſurrounded with an atmoſphere like ours, ſo variable in its denſity, and ſo frequently obſcured by clouds and vapours. 2. In an appulſe of the moon to a ſtar, when ſhe comes ſo near it that part of her atmoſphere is interpoſed between our eye and the ſtar, refraction would cauſe the latter ſeem to change its place, ſo that the moon would appear to touch it later than by her own motion ſhe would do. 3. Some philoſophers are of opinion, that becauſe there are no ſeas or lakes in the moon, there is therefore no atmoſphere, as there is no water to be raiſed up in vapours.

All theſe arguments, however, have been anſwered by other aſtronomers in the following manner. 1. It is denied that the moon appears always with the ſame brightneſs, even when our atmoſphere appears equally clear. Hevelius relates, that he has ſeveral times found in ſkies perfectly clear, when even ſtars of the ſixth and ſeventh magnitude were viſible, that at the ſame altitude of the moon and the ſame elongation from the earth, and with one and the ſame teleſcope, the moon and its maculæ do not appear equally lucid, clear, and conſpicuous at all times; but are much brighter and more diſtinct at ſome times than at others. From the circumſtances of this obſervation, ſay they, it is evident that the reaſon of this phenomenon is neither in our air, in the tube, in the moon, nor in the ſpectator's eye; but muſt be looked for in ſomething exiſting about the moon. An additional argument is drawn from the different appearances of the moon already mentioned in total eclipſes, which are ſuppoſed to be owing to the different conſtitutions of the lunar atmoſphere.

To the ſecond argument Dr Long replies, that Sir Iſaac Newton has ſhown (*Princip.* prop. 37. cor. 5.), that the weight of any body upon the moon is but a third part of what the weight of the ſame would be upon the earth: now the expanſion of the air is reciprocally as the weight that compreſſes it: the air, therefore, ſurrounding the moon, being preſſed together by a weight, or being attracted towards the centre of the moon by a force equal only to one-third of that which attracts our air towards the centre of the earth, it thence follows, that the lunar atmoſphere is only one-third as denſe as that of the earth, which is too little to produce any ſenſible refraction of the ſtar's light. Other aſtronomers have contended that ſuch refraction was ſometimes very apparent. Mr. Caſſini ſays that he frequently obſerved Saturn, Jupiter, and the fixed ſtars, to have their circular figure changed into an elliptical one, when they approached either to the moon's dark or illuminated limb, though they

148 Why the light is not refracted by the moon's atmoſphere.

Conclusions from the foregoing Appearances.

own, that, in other occultations, no such change could be observed. With regard to the fixed stars, indeed, it has been urged, that, granting the moon to have an atmosphere of the same nature and quantity as ours, no such effect as a gradual diminution of light ought to take place; at least, that we could by no means be capable of perceiving it. Our atmosphere is found to be so rare at the height of 44 miles as to be incapable of refracting the rays of light. This height is the 180th part of the earth's diameter; but since clouds are never observed higher than four miles, we must conclude that the vaporous or obscure part is only one 1980th. The mean apparent diameter of the moon is 31′ 29″, or 1889 seconds: therefore the obscure parts of her atmosphere, when viewed from the earth, must subtend an angle of less than one second; which space is passed over by the moon in less than two seconds of time. It can therefore hardly be expected that observation should generally determine whether the supposed obscuration takes place or not.

The third argument is necessarily inconclusive, because we know not whether there is any water in the moon or not; nor, though this could be demonstrated, would it follow that the lunar atmosphere answers no other purpose than the raising of water into vapour.

149 Luminous ring observed about the moon in total eclipses.

There is, however, a strong argument in favour of the existence of a lunar atmosphere, taken from the appearance of a luminous ring round the moon in the time of solar eclipses. In the eclipse of May 1, 1706, Captain Stanyan, from Bern in Switzerland, writes, that "the sun was totally darkened there for the space of four minutes and a half: that a fixed star and planet appeared very bright: that his getting out of the eclipse was preceded by a blood-red streak of light from his left limb, which continued not longer than six or seven seconds of time; then part of the sun's disk appeared, all on a sudden, brighter than Venus was ever seen in the night; and in that very instant gave light and shadow to things as strong as moon-light uses to do." The publisher of this account observes, that the red streak of light preceding the emersion of the sun's body, is a proof that the moon has an atmosphere; and its short continuance of five or six seconds shows that its height is not more than the five or six hundredth part of her diameter.

Fatio, who observed the same eclipse at Geneva, tells us, that "there was seen, during the whole time of the total immersion, a whiteness which seemed to break out from behind the moon, and to encompass her on all sides equally: this whiteness was not well defined on its outward side, and the breadth of it was not a twelfth part of the diameter of the moon. The planet appeared very black, and her disk very well defined with the whiteness which encompassed it about, and was of the same colour as that of a white crown or halo of about four or five degrees in diameter, which accompanied it, and had the moon for its centre. A little after the sun had begun to appear again, the whiteness, and the crown which had encompassed the moon did entirely vanish." "I must add (says Dr Long), that this description is a little perplexed, either through the fault of the author or of the translator; for I suppose Fatio wrote in French; however, it plainly appears by it that the moon's atmosphere was visible, surrounded by a light of larger extent, which I think must be that luminous appearance (the zodiacal light) mentioned from Cassini." Flamstead, who published this account, takes notice, that, according to these observations, the altitude of the moon's atmosphere cannot be well supposed less than 130 geographical miles; and that probably this atmosphere was never discovered before this eclipse, by reason of the smallness of the refraction, and the want of proper observations.

Conclusions from the foregoing Appearances.

An account of the same eclipse as it appeared at Zurich, is given by Dr Scheuchzer, in the following words: "We had an eclipse of the sun, which was both total and annular: total, because the whole sun was covered by the moon; annular, not what is properly so called, but by refraction; for there appeared round the moon a bright shining, which was owing to the rays of the sun refracted through the atmosphere of the moon.

Dom. Cassini, from a number of accounts sent him from different parts, says, that in all those places where it was total, during the time of total darkness, there was seen round the moon a crown or broad circle of pale light, the breadth whereof was about a 12th part of the moon's diameter: that at Montpelier, where the observers were particularly attentive to see if they could distinguish the zodiacal light already mentioned, they took notice of a paler light of a larger extent, which surrounded the crown of light before mentioned, and spread itself on each side of it, to the distance of four degrees. He then mentions Kepler's opinion, that the crown of light which appears round the moon during the total darkness in an eclipse of the sun, is caused by some celestial matter surrounding the moon, of sufficient density to receive the rays of the sun and send them to us; and that the moon may have an atmosphere similar to that of our earth, which may refract the sun's light.

150 Dr Halley's account of a solar eclipse in 1715.

A total eclipse of the sun was observed on the 22d of April O. S. in the year 1715, by Dr Halley at London, and by M. Louville of the Academy of Sciences at Paris. Dr Halley relates, that "when the last part of the sun remained on his east side, it grew very faint, and was easily supportable to the naked eye even through the telescope, for above a minute of time before the total darkness; whereas, on the contrary, the eye could not endure the splendor of the emerging beams through the telescope even from the first moment. To this two causes perhaps concurred: the one, that the pupil of the eye did necessarily dilate itself during the darkness, which before had been much contracted by looking on the sun: the other, that the eastern parts of the moon, having been heated with a day near as long as 30 of ours, must of necessity have that part of its atmosphere replete with vapours raised by the so long continued action of the sun; and, by consequence, it was more dense near the moon's surface, and more capable of obstructing the sun's beams; whereas at the same time the western edge of the moon had suffered as long a night, during which there might fall in dews all the vapours that were raised in the preceding long day; and for that reason, that part of its atmosphere might be seen much more pure and transparent.

"About two minutes before the total immersion, the remaining part of the sun was reduced to a very fine horn, whose extremities seemed to loose their acute-

ness,

Conclusions from the foregoing Appearances.

neſs, and to become round like ſtars; and for the ſpace of about a quarter of a minute a ſmall piece of the ſouthern horn of the eclipſe ſeemed to be cut off from the reſt by a good interval, and appeared like an oblong ſtar rounded at both ends: which appearance would proceed from no other cauſe but the inequalities of the moon's ſurface: there being ſome elevated parts thereof near the moon's ſouthern pole, by whoſe interpoſition part of that exceedingly fine filament of light was intercepted. A few ſeconds before the ſun was totally hid there diſcovered itſelf round the moon a luminous ring about a digit, or perhaps a tenth part of the moon's diameter in breadth. It was of a pale whiteneſs, or rather of a pearl colour, ſeeming to me a little tinged with the colour of the iris and to be concentric with the moon; whence I concluded it the moon's atmoſphere. But the great height of it, far exceeding that of our earth's atmoſphere, and the obſervations of ſome who found the breadth of the ring to increaſe on the weſt ſide of the moon as the emerſion approached, together with the contrary ſentiments of thoſe whoſe judgments I ſhall always revere, make me leſs confident, eſpecially in a matter to which I gave not all the attention requiſite.

"Whatever it was, this ring appeared much brighter and whiter near the body of the moon than at a diſtance from it; and its outward circumference, which was ill defined, ſeemed terminated only by the extreme rarity of the matter of which it was compoſed, and in all reſpects reſembled the appearance of an enlightened atmoſphere ſeen from far: but whether it belonged to the ſun or moon, I ſhall not pretend to determine. During the whole time of the total eclipſe, I kept my teleſcope conſtantly fixed on the moon, in order to obſerve what might occur in this uncommon appearance; and I ſaw perpetual flaſhes or coruſcations of light, which ſeemed for a moment to dart out from behind the moon, now here, now there, on all ſides, but more eſpecially on the weſtern ſide, a little before the emerſion; and about two or three ſeconds before it, on the ſame weſtern ſide, where the ſun was juſt coming out, a long and very narrow ſtreak of duſky but ſtrong red light ſeemed to colour the dark edge of the moon, though nothing like it had been ſeen immediately after the immerſion. But this inſtantly vaniſhed after the appearance of the ſun, as did alſo the aforeſaid luminous ring."

151 Flaſhes of light appear to dart from behind the moon.

152 Mr Louville's obſervations.

Mr Louville relates, that a luminous ring of a ſilver colour appeared round the moon as ſoon as the ſun was entirely covered by her diſk, and diſappeared the moment he recovered his light; that this ring was brighteſt near the moon, and grew gradually fainter towards its outer circumference, where it was, however, defined; that it was not equally bright all over, but had ſeveral breaks in it: but he makes no doubt of its being occaſioned by the moon's atmoſphere, and thinks that the breaks in it were occaſioned by the mountains of the moon: he ſays alſo, that this ring had the moon, and not the ſun, for its centre, during the whole time of its appearance. Another proof brought by him of the moon having an atmoſphere is, that, towards the end of the total darkneſs, there was ſeen on that ſide of the moon on which the ſun was going to appear, a piece of a circle of a lively red, which might be owing to the red rays that are leaſt refrangible being tranſmitted through the moon's atmoſphere in the greateſt quantity: and that he might be aſſured this redneſs did not proceed from the glaſſes of his teleſcope, he took care to bring the red part into the middle of his glaſſes.

Conclusions from the foregoing Appearances.

He lays great ſtreſs on the ſtreaks of light which he ſaw dart inſtantaneouſly from different places of the moon during the time of total darkneſs, but chiefly near the eaſtern edge of the diſk: theſe he takes to be lightning, ſuch as a ſpectator would ſee flaſhing from the dark hemiſphere of the earth, if he were placed upon the moon and ſaw the earth come between himſelf and the ſun. "Now (ſays Dr Long) it is highly probable, that if a man had, at any time, a view of that half of the earth where it is night, he would ſee lightning in ſome part of it or other." Louville farther obſerves, that the moſt mountainous countries are moſt liable to tempeſts; and that mountains being more frequent in the moon, and *higher, than on earth**, thunder and lightning muſt be more frequent there than with us; and that the eaſtern ſide of the moon would be moſt ſubject to thunder and lightning, thoſe parts having been heated by the ſun for half the month immediately preceding. It muſt here be obſerved, that Halley, in mentioning theſe flaſhes, ſays they ſeemed to come from behind the moon; and Louville, though he ſays they came ſometimes from one part and ſometimes from another, owns, that he himſelf only ſaw them near the eaſtern part of the diſk; and that, not knowing at that time what it was that he ſaw, he did not take notice whether the ſame appearance was to be ſeen on the other parts of the moon or not. He tells us, however, of an Engliſh aſtronomer, who preſented the Royal Society with a draught of what he ſaw in the moon at the time of this eclipſe; from which Louville ſeems to conclude that lightnings had been obſerved by that aſtronomer near the centre of the moon's diſk. "Now (ſays Dr Long) thunder and lightning would be a demonſtration of the moon having an atmoſphere ſimilar to ours, wherein vapours and exhalations may be ſupported, and furniſh materials for clouds, ſtorms, and tempeſts. But the ſtrongeſt proof brought by Louville of the moon having an atmoſphere is this, that as ſoon as the eclipſe began, thoſe parts of the ſun which were going to be hid by the moon grew ſenſibly paliſh as the former came near them, ſuffering beforehand a kind of imperfect eclipſe or diminution of light; this could be owing to nothing elſe but the atmoſphere of the moon, the eaſtern part whereof going before her reached the ſun before the moon did. As to the great height of the lunar atmoſphere, which from the breadth of the luminous ring being about a whole digit would upon a calculation come out 180 miles, above three times as high as the atmoſphere of the earth, Louville thinks that no objection; ſince, if the moon were ſurrounded with an atmoſphere of the ſame nature with that which encompaſſes the earth, the gravitation thereof towards the moon would be but one-third of that of our atmoſphere towards the earth; and conſequently its expanſion would make the height of it three times as great from the moon as is the height of our atmoſphere from the earth."

153 Lightning ſuppoſed to be frequent in the moon.

*Seen°142 *et ſeq.*

154 Great height of the lunar atmoſphere accounted for.

The ſame luminous ring has been obſerved in other total eclipſes, and even in ſuch as are annular, though without the luminous ſtreaks or flaſhes of lightning a-

Conclusions from the foregoing Appearances.

bovementioned; it is even taken notice of by Plutarch: however, ſome members of the academy at Paris have endeavoured to account for both theſe phenomena without having recourſe to a lunar atmoſphere; and for this purpoſe they made the following experiments.

155 Theſe phenomena otherwiſe accounted for.

The image of the ſun coming through a ſmall hole into a darkened room, was received upon a circle of wood or metal of a diameter a good deal larger than that of the ſun's image; then the ſhadow of this opaque circle was caſt upon white paper, and there appeared round it, on the paper, a luminous circle ſuch as that which ſurrounds the moon. The like experiment being made with a globe of wood, and with another of ſtone not poliſhed, the ſhadows of both theſe caſt upon paper were ſurrounded with a paliſh light, moſt vivid near the ſhadows, and gradually more diluted at a diſtance from them. They obſerve alſo, that the ring round the moon was ſeen in the eclipſe of 1706 by Wurzelbaur, who caſt her ſhadow upon white paper. The ſame appearance was obſerved on holding an opaque globe in the ſun, ſo as to cover his whole body from the eye; for, looking at it through a ſmoked glaſs, in order to prevent the eye from being hurt by the glare of light it would otherwiſe be expoſed to, the globe appeared ſurrounded with a light reſembling that round the moon in a total eclipſe of the ſun.

Thus they ſolve the phenemenon of the ring ſeen round the moon by the inflection, or *diffraction* as they call it, of the ſolar rays paſſing near an opaque ſubſtance. As for the ſmall ſtreaks of light abovementioned, and which are ſuppoſed to be lightning, they explain theſe by an hypotheſis concerning the cavities of the moon themſelves; which they conſider as concave mirrors reflecting the light of the ſun nearly to the ſame point; and as theſe are continually changing their ſituation with great velocity by the moon's motion from the ſun, the light which any one of them ſends to our eye is ſeen but for a moment. This, however, will not account for the flaſhes, if any ſuch there are, ſeen near the centre of the diſk, though it does, in no very ſatisfactory manner, account for thoſe at the edges.

156 Occultations of the fixed ſtars by the moon.

It has already been obſerved, that the occultations of the fixed ſtars and planets by the moon in general happen without any kind of refraction of their light by the lunar atmoſphere. The contrary, however, has ſometimes been obſerved, and the ſtars have been ſeen manifeſtly to change their ſhape and colour on going behind the moon's diſk. An inſtance of this happened on the 28th of June N. S. in the year 1715, when an occultation of Venus by the moon happened in the day-time. Some aſtronomers in France obſerving this with a teleſcope, ſaw Venus change colour for about a minute before ſhe was hid by the moon; and the ſame change of colour was obſerved immediately after her emerſion from behind the diſk. At both times the edge of the diſk of Venus that was neareſt the moon appeared reddiſh, and that which was moſt diſtant of a bluiſh, colour. Theſe appearances, however, which might have been taken for proofs of a lunar atmoſphere, were ſuppoſed to be owing to the obſervers having directed the axes of their teleſcopes towards the moon. This would neceſſarily cauſe any planet or ſtar near the edge of the moon's diſk to be ſeen through thoſe parts of the glaſſes which are near their circumference, and conſequently to appear coloured. This was evidently the caſe from other obſervations of an occultation of Jupiter by the moon the ſame year, when no ſuch appearance of refraction could be perceived while he was kept in the middle of the teleſcope. Maraldi alſo informs us, that he had obſerved before this two other occultations of Venus and one of Jupiter; and was always attentive to ſee whether thoſe planets changed their figure or colour either upon the approach of the moon to cover them, or at their firſt coming again into ſight; but never could perceive any ſuch thing. Nor could he, in a great number of occultations of the fixed ſtars, perceive the ſmalleſt apparent change in any of them, excepting once that a fixed ſtar ſeemed to increaſe its diſtance a little from the moon as it was going to be covered by her; but this, he ſuſpected, might be owing to his teleſcope being directed ſo as to have the ſtar ſeen too far from the middle of its aperture. He concludes, therefore, that the moon has no atmoſphere: and he remarks, that at Montpelier, perhaps becauſe the air is clearer there than at London, the luminous ring round the moon appeared much larger than at London; that it was very white near the moon, and gradually decreaſing in brightneſs formed round her a circular area of about eight degrees in diameter. If, ſays he, this light was cauſed by the atmoſphere of the moon, of what a prodigious extent muſt that atmoſphere be?

Conclusions from the foregoing Appearances.

157 Of a plurality of worlds.

Before we enter upon any further ſpeculations concerning the celeſtial bodies, we ſhall here take ſome notice of the doctrine of a plurality of worlds; to which we are naturally led by the queſtion, Whether the moon is inhabited or not? This is an hypotheſis of very ancient date, and which in modern times has been revived in ſuch a manner as now to be almoſt adopted as an undoubted truth. Plutarch, Diogenes, Laertius, and Stobæus, informs us, that this doctrine was embraced by ſeveral of the ancient Greek philoſophers; from which authors Gregory has given us extracts in the Preface to his Aſtronomy. "Among the moderns (ſays Dr Long), Huygens has written a treatiſe, which he calls *Coſmotheoros*, or *A view of the world*, worth peruſing. One thing, however, I muſt find fault with; that, in peopling the planets with reaſonable creatures, he inſiſts upon their being in all points exactly ſimilar to the human race, as to the ſhape of their bodies and the endowments of their minds: this is too confined a thought; for we cannot but acknowledge that infinite power and wiſdom is able to form rational beings of various kinds, not only in ſhape and figure different from the human, but endowed alſo with faculties and ſenſes very different; ſuch as in our preſent ſtate we can have no idea of." With regard to the probability of the doctrine itſelf, the Doctor expreſſes himſelf in the following manner. "That the earth and all the creatures thereon were created to be ſubſervient to the uſe of man, we may believe upon the authority of the ſacred writer, Pſalm viii. but that the ſtars and planets were formed only to beſpangle the canopy of heaven with their glimmering, which does not furniſh us with the twentieth part of the light the moon gives, I think is not at all probable: this is contrary to the obſervation made by the beſt philoſophers, that nature is magnificent in all her deſigns, but frugal in the execution of them. It is commonly ſaid, that

nature

Fig. 74.

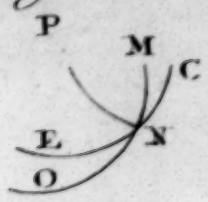

Fig. 75.

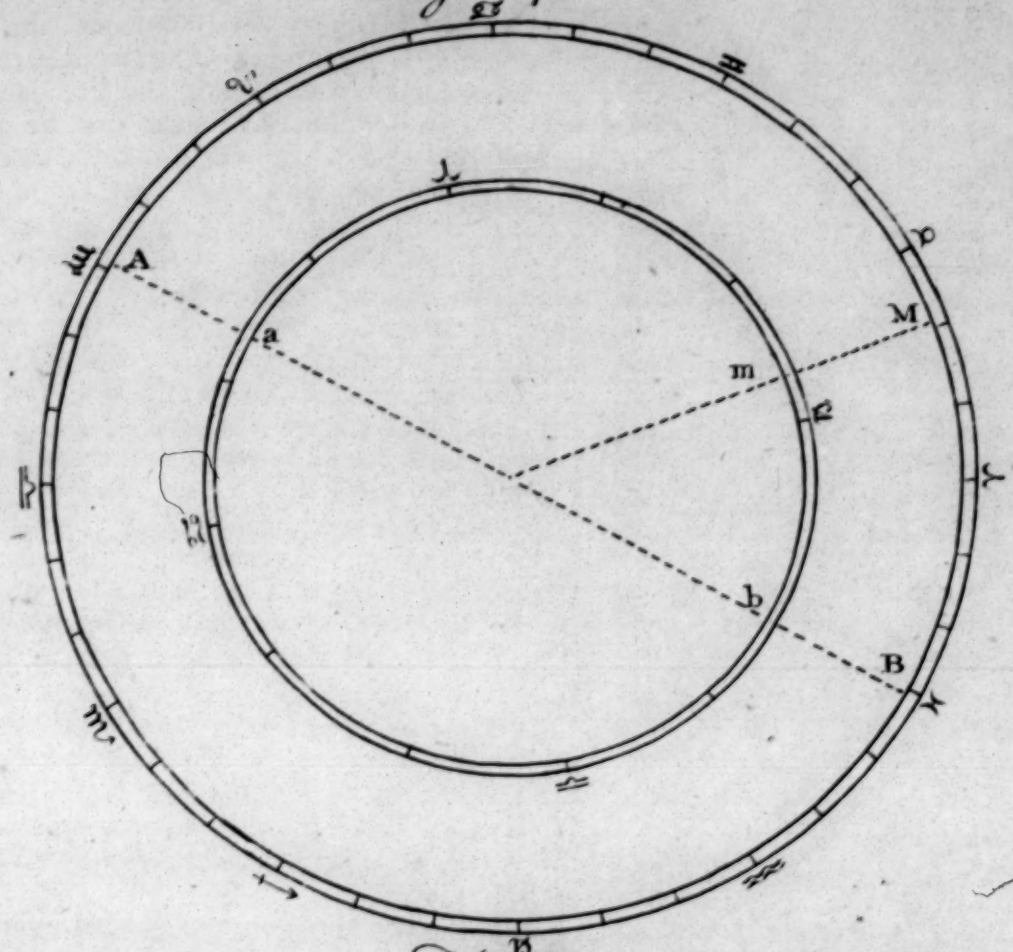

Fig. 76.

Fig. 77.

Fig. 78.

Fig. 79.

Fig. 80.

Fig. 81.

Fig. 82.

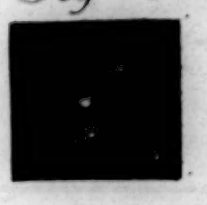

Fig. 84.

Fig. 83.

Fig. 85.

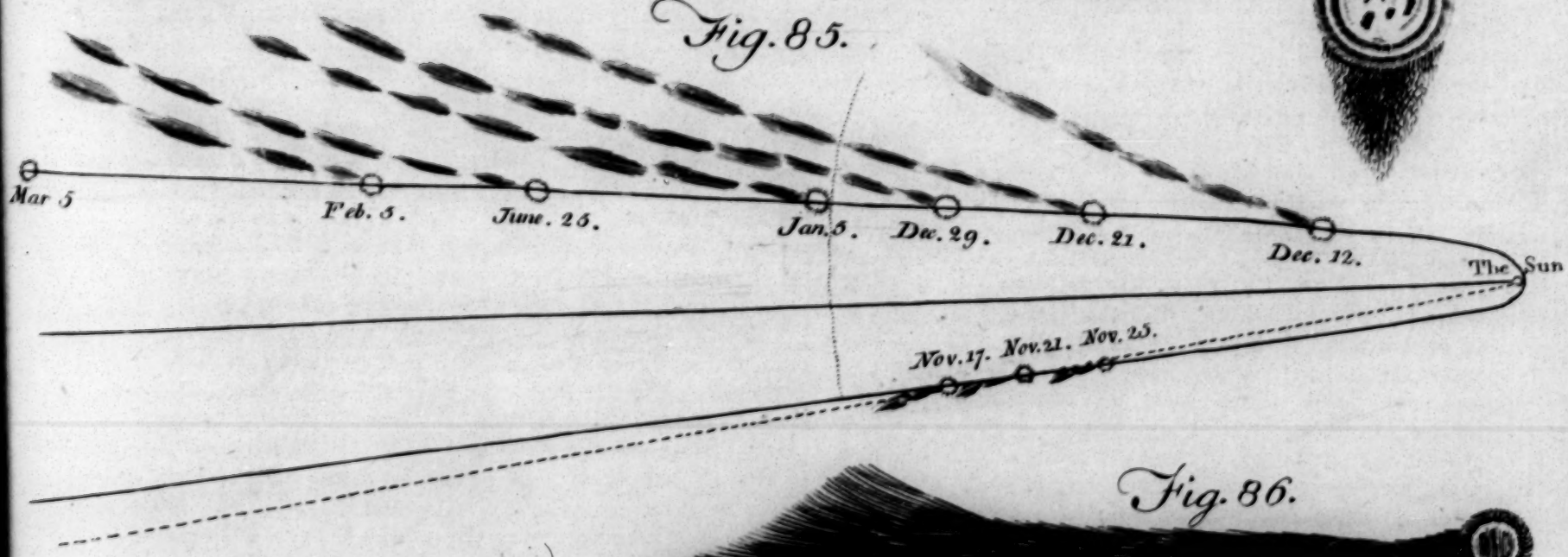

Fig. 86.

Fig. 87.

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nature does nothing in vain: now by *Nature*, in a ſound ſenſe, muſt be underſtood the preſent order and diſpoſition of things according to the will of the ſupreme Being."

158 Objections to the poſſibility of this doctrine.

Objections have been made to the poſſibility of this hypotheſis from the different degrees of heat and light which the planets receive from the ſun, according to their various diſtances from him. On Venus, for inſtance, the heat muſt be more than double what it is with us, and on Mercury upwards of ten times as great; ſo that were our earth brought as near the ſun as Mercury, every drop of liquid would be evaporated into ſteam, and every combuſtible ſolid ſet on fire; while, on the other hand, were we removed to the diſtance of the ſuperior planets, ſuch as the Georgium Sidus, Saturn, or even Jupiter, there is the higheſt probability that our liquids would all be congealed into ice, at the ſame time that the climate would be utterly inſupportable by ſuch creatures as we are. Objections of the ſame kind are drawn from the ſmall quantity of light which falls upon the more diſtant planets, which it is thought would be inſufficient for the purpoſes of living and rational creatures. Such arguments as theſe, however, are by no means concluſive; for as Dr Long juſtly obſerves, "we are ſure, that if the all-wiſe ſupreme Being hath placed animals on the planets, he has fitted the inhabitants to the places, and the places to the inhabitants." We ſhall therefore only add the following quotation from Mr Nicholſon † concerning final cauſes, which ſums up all that can be ſaid with propriety in favour of the doctrine in queſtion.—"The purpoſes or motives (ſays he) which determine the actions of intelligent beings, and produce their effects in a manner ſimilar to the operation of the laws of nature, or the properties of matter in caſes where thought is not ſuppoſed to concerned, are called *final cauſes*. In the works of nature we behold enough of exquiſite contrivance, and can ſee far enough into many final cauſes, to convince us that the arrangement of the univerſe has been made, and probably ſtill is occaſionally adjuſted, by a Being whoſe intelligence and power are immenſely beyond what we poſſeſs. To judge properly of his intentions, or, in other words, to be equal to the taſk of exploring final cauſes, requires no leſs than a perfect knowledge and recollection of every purpoſe to which the objects around us may be applied, together with a clear conception of the ideas of fitneſs and order that form the prototypes in the mind of that Great Being who directs their motions. Theſe conſiderations ſhow the abſurdity of attempting to explain the final cauſes of every event we ſee; but they by no means require that we ſhould neglect them in caſes where we have reaſon to believe that we underſtand the phenomena, and have ſufficient experience to be aſſured that we diſcern the principal, or at leaſt one of the principal, purpoſes to which things may have been deſtined. Thus it is ſcarcely to be imagined that we can err in concluding, that the eyes, ears, legs, wings, and other parts of animals were made for the purpoſes of ſeeing, hearing, walking, flying, and ſo forth. Neither can we avoid inferring, that the Power who conſtructed living creatures with mouths, teeth, and organs to digeſt and aſſimilate food for their nutriment, did likewiſe form other organized bodies, which we call *vegetables*, for the expreſs purpoſe of affording that food. It is needleſs to multiply inſtances. We cannot avoid ſeeing them every moment; and their effect is ſo ſtriking, that we are inſenſibly forced from analogy to allow the exiſtence of a final cauſe in all caſes, whether we are able to diſcover it or not.

160 Inconcluſive.

† *Introd. to Nat. Phil.* page 141. Philad. Edition.

Concluſions from the foregoing Appearances.

"On this ground, an inquiry into the final cauſes of the planetary bodies offers itſelf to our conſideration. The earth is ſhown to be a planet in circumſtances very ſimilar to the other five: we know its final cauſe—to ſupport a number of inhabitants: And by analogy we may conclude that the others are alſo habitable worlds; though, from their different proportions of heat, it is credible that beings of our make and temperature could not live upon them. However, even that can ſcarcely be affirmed of all the planets; for the warmeſt climate on the planet Mars is not colder than many parts of Norway or Lapland are in the ſpring or autumn. Jupiter, Saturn, and the Georgium Sidus, it muſt be granted, are colder than any of the inhabited parts of our globe. The greateſt heat on the planet Venus exceeds the heat on the iſland of St Thomas on the coaſt of Guinea, or Sumatra in the Eaſt Indies, about as much as the heat in thoſe places exceeds that of the Orkney iſlands, or the city of Stockholm in Sweden: therefore, at 60° north latitude on that planet, if its axis were perpendicular to the plane of its orbit, the heat would not exceed the greateſt heat on the earth; and of courſe vegetation like ours might be there carried on, and animals of the ſpecies on earth might ſubſiſt. If Mercury's axis be ſuppoſed to have a like poſition, a circle of about 20° diameter round each pole would enjoy the ſame temperature as the warmer regions of the earth, though in its hotteſt climate water would continually boil, and moſt inflammable ſubſtances would be parched up, deſtroyed, or converted into vapour. But it is not at all neceſſary that the planets ſhould be peopled with animals like thoſe on the earth; the Creator has doubtleſs adapted the inhabitants of each to their ſituation.

161 Of the various climates of the planets.

162 Compariſon of the light of the ſuperior planets with our day.

"From the obſervations that have been juſt made, a better idea may be formed of the proportions of heat on the planets than can be conveyed by numbers. It will not, however, be remote from our purpoſe to compare the light of the ſuperior planets with that of our day; from whence it will appear, that they are by no means in a ſtate of darkneſs notwithſtanding their great diſtance from the ſun. This might be inſtanced by ſeveral different methods; as by the ſun's light admitted into a dark chamber, and received on paper with different degrees of obliquity; by a greater or leſs number of candles brought into a room for the purpoſe of illuminating it with various degrees of light; or by various optical methods that need not here be deſcribed. It will be ſufficient for the illuſtration of the ſubject to compare their different proportions of light with that of a moonſhine night at the time of full.

"When the moon is viſible in the day-time, its light is ſo nearly equal to that of the lighter thin clouds, that it is with difficulty diſtinguiſhed among them. Its light continues the ſame during the night; but the abſence of the ſun ſuffering the pupil of the eye to dilate itſelf, it become more conſpicuous. It therefore follows, that if every part of the ſky were equally

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equally luminous with the moon's disk, the light would be the same as if in the day-time it were covered with the thin clouds abovementioned. This day-light is consequently in proportion to that of the moon as the whole surface of the sky or visible hemisphere is to the surface of the moon; that is to say, nearly as 90,000 to 1. The light of the Georgium Sidus being to that of the earth as 0.276 to 100, will be equal to the effect of 248 full moons. Jupiter's day will equal the light of 3,330 moons; and that of Mars will require 38,700, a number so great that they would almost touch one another. It is even probable, that the comets in the most distant parts of their orbits enjoy a degree of light much exceeding moonshine."

Of all the celestial bodies, comets have given rise to the greatest number of speculations and conjectures. Their strange appearance has in all ages been a matter of terror to the vulgar, who uniformly have looked upon them to be evil omens and forerunners of war, pestilence, &c. Others, less superstitious, supposed them to be meteors raised in the higher regions of the air. But we find that some part of the modern doctrine concerning them had been received into the ancient Italic and Pythagorean schools: for they held them to be so far of the nature of planets, that they had their periodical times of appearing; that they were out of sight for a long time, while they were carried aloft at an immense distance from the earth, but become visible when they descended into the lower regions of the air, when they were nearer to us.

163 Supposed by the ancients to be planets.

These opinions were probably brought from Egypt, from whence the Greeks borrowed great part of their learning. However, it seems not to have been generally received; for Aristotle, who mentions it, asserted that the heavens were unchangeable, and not liable to generation or corruption. Comets, therefore, which he believed to be generated when they first made their appearance, and destroyed when they vanished from our sight, he maintained could not be heavenly bodies, but rather meteors or exhalations raised into the upper regions of the atmosphere, where they blazed out for a while, and disappeared when the matter of which they were formed was consumed. Seneca, who lived in the first century, mentions Appollonius of Myndus, a very careful observer of natural causes, to have been of the same sentiments with the most ancient Greek philosophers with regard to comets. He himself had seen two; one in the reign of Claudius, the other in that of Nero; besides another which he saw while a boy, before the death of Augustus. He plainly intimates, that he thought them above the moon; and argues strongly against those who supposed them to be meteors, or held other absurd opinions concerning them; declaring his belief that they were not fires suddenly kindled, but the eternal productions of nature. He points out also the only way to come at a certainty on this subject, viz. by collecting a number of observations concerning their appearance, in order to discover whether they return periodically or not. "For this purpose (says he) one age is not sufficient; but the time will come when the nature of comets and their magnitudes will be demonstrated, and the routs they take, so different from the planets, explained. Posterity will then wonder that the preceding ages should be ignorant of matters so plain and easy to be known."

164 Aristotle's opinion concerning them.

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For a long time this prediction of Seneca seemed very unlikely to be fulfilled. The great authority which Aristotle maintained for many ages, determined them to be nothing but meteors casually lighted up in the air; though they were manifestly at a great height, not only above the clouds, but subject to the diurnal revolution of the earth. In the dark and superstitious ages, they were held to be the forerunners of every kind of calamity, and were supposed to have different degrees of malignity according to the shape they assumed; from whence also they were differently denominated. Thus, some were said to be bearded, some hairy; some to represent a beam, sword, or spear; others a target, &c.; whereas modern astronomers acknowledge only one species of comets, and account for their different appearances from their different situations from the sun and earth.

165 Only one species of them exists.

166 Kepler and Bodin's opinion of them.

It was not till some time after people began to throw off the fetters of superstition and ignorance which had so long held them, that any rational hypothesis was formed concerning comets. Kepler, in other respects a very great genius, indulged the most extravagant conjectures, not only concerning comets, but the whole system of nature in general. The planets he imagined to be huge animals who swam round the sun by means of certain fins acting upon the ethereal fluid, as those of fishes do on the water: and agreeable to this notion, he imagined the comets to be monstrous and uncommon animals generated in the celestial spaces; and he explained how the air engendered them by an animal faculty. A yet more ridiculous opinion, if possible, was that of John Bodin, a learned man of France in the 16th century. He maintained that comets "are spirits, which having lived on the earth innumerable ages, and being at last arrived on the confines of death, celebrate their last triumph, or are recalled to the firmament like shining stars! This is followed by famine, plague, &c. because the cities and people destroy the governors and chiefs who appease the wrath of God." This opinion he says he borrowed from the philosopher Democritus, who imagined them to be the souls of famous heroes: but that being irreconcileable with Bodin's Christian sentiments, he was obliged to suppose them to be a kind of genii, or spirits subject to death, like those so much mentioned in the Mahometan fables. Others, again, have denied even the existence of comets, and maintained that they were only false appearances occasioned by the refraction or reflection of light.

167 Bernouilli's opinion.

The first rational conjecture we meet with is that of James Bernouilli, an Italian astronomer, who imagined them to be the satellites of some very distant planet, which was invisible to us on account of its distance, as were also the satellites unless when in a certain part of their course.

168 True doctrine concerning them revived by Tycho Brache.

Tycho Brache was the first who restored the comets to their true rank in the creation. Before his time, several comets had been observed with tolerable exactness by Regiomontanus, Appian, Fabricius, and others; yet they all thought them below the moon. But Tycho, being provided with much better instruments set himself with great diligence to observe the famous

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famous comet of 1577: and from many careful obſervations, deduced that it had no ſenſible diurnal parallax; and therefore was not only far above the regions of our atmoſphere, but much higher than the moon. But though few have come ſo near the earth as to have any diurnal parallax, all of them have what may be called an annual parallax; that is, the revolution of the earth in her orbit cauſes their apparent motion to be very different from what it would be if viewed from the ſun; and this ſhows them to be much nearer than the fixed ſtars, which have no ſuch parallax. Kepler, the diſciple of Tycho, notwithſtanding his ridiculous conjecture already mentioned, was very attentive to the motions of the comets, and found that they did not move in ſtraight lines, as had been ſuppoſed. He ſhowed that their paths were concave towards the ſun, and ſuppoſed them to move in parabolic trajectories.

169 Their motion exactly determined by Sir Iſaac Newton.

Their true motion, however, was only diſcovered from the obſervations made by Sir Iſaac Newton on the great comet of 1680. This deſcended almoſt perpendicularly towards the ſun with a prodigious velocity; aſcending again with the ſame velocity retarded, as it had been before accelerated. It was ſeen in the morning by a great number of aſtronomers in different parts of Europe, from the 4th to the 25th of November, in its way towards the ſun; and in the evening from the 12th of December to the 9th of March following. The many exact obſervations made on this comet, enabled Sir Iſaac Newton to determine that they are a kind of planets which move in very eccentric ellipſis; and this opinion is now looked upon to be certainly eſtabliſhed. It was oppoſed, however, by M. de la Hire, and ſome other French philoſophers; and it is evident that the whole diſpute now turned on mere practical obſervation. If the return of any comet could be predicted, and its periodical time calculated like that of a planet, then the doctrine might be concluded certainly true, but not otherwiſe. Dr Halley therefore ſet himſelf to collect all the obſervations he could on comets; and afterwards calculated the orbits of twenty-four of them, on a ſuppoſition of their being paraboles; but afterwards found that they agreed better with the ſuppoſition of their motion being performed in very eccentric elliptical orbits. On this he calculated a table of their elements; from which it was manifeſt that they were not comprehended in the zodiac, ſome of them making an angle of upwards of 80° with the ecliptic.

170 Dr Halley predicts a comet's return.

171 Periodical times of different comets determined.

By computations founded on theſe elements, the Doctor concluded that the comet of 1682, was the ſame which had appeared in 1607 and 1531; that it had a period of 75 or 76 years; and he ventured to foretel that it would return about the year 1758. The comet which appeared in 1661 was ſuppoſed to be the ſame with that of 1532, and to have a period of 129 years; and from the equality of periods, and ſimilitude of appearances, it was concluded that the great comet of 1680 was the ſame which had appeared in 1106 in the time of Henry I. and the conſulate of Lampadius and Oreſtes about the year 531, and in the year 44 B. C. before Julius Cæſar was murdered; and thence concluded that its period was 575 years. Mr Dunthorne, however, has endeavoured to ſhow from a MS. in Pembroke-hall library, that the comet of 1106 could not be the ſame with that of 1680; but M. de la Lande thinks the four appearances related by Dr Halley ſtronger proofs than a ſingle obſervation, which might be very faulty.

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Since the time of Dr Halley other aſtronomers have calculated the elements of 25 other comets: all of which, excepting one of three which appeared in 1759, and which differs but little from that of 1531, 1607, and 1682, and is therefore accounted the ſame; differ very much from each other; ſo that we cannot help concluding them all to be different, and that the number of theſe bodies is very great. "It is not, however, unlikely (ſays Dr Long), from the immenſe interval between the orbit of Saturn and the neareſt fixed ſtars, that many of them have not deſcended into the planetary regions ſince they have been looked upon as celeſtial bodies, and obſerved accordingly; beſides, it may often happen, that a body may finiſh its whole period without being obſerved by us, on account of the unfavourable ſituation of the earth in her orbit when the comet is in its perihelion. Thus, if the comet be either behind or before the ſun, or nearly ſo, it muſt be above our horizon in the day-time, and conſequently inviſible, except the ſun ſhould at that time be in a total eclipſe; for then the comet might be ſeen near the ſun, as well as the ſtars and planets are: and this caſe is ſaid to have happened; for Seneca relates from Poſſidonius, that a comet was ſeen when the ſun was eclipſed, which had before been inviſible by being near that luminary."

172 Why comets may ſometimes be inviſible even in their perihelion.

173 Why more are ſeen in the hemiſphere towards the ſun than in the oppoſite.

A greater number of comets are ſeen in the hemiſphere towards the ſun than in the oppoſite; the reaſon of which will eaſily appear from fig. 97. wherein S repreſents the ſun, E the earth, ABCD the ſphere of the fixed ſtars: and becauſe comets either do not reflect the light enough to be viſible, or emit tails conſpicuous enough to attract our notice, till they come within the planetary regions, commonly a good way within the ſphere of Jupiter, let KLMN be a ſphere concentric to the ſun, at ſuch a diſtance from him, that no comet can be ſeen by us till it come within that diſtance; through E draw the plane BD perpendicular to SE, which will divide the ſphere KLMN into two hemiſpheres, one of which BCD, is towards the ſun, the other, DAB, oppoſite. Now it is manifeſt, that the ſpherical portion LMN, which is in the hemiſphere BCD towards the ſun, is larger than the portion NKL in the hemiſphere oppoſite to him; and conſequently a greater number of comets will appear in the hemiſphere BCD than in that marked DAB.

174 Great differences in the eccentricities of the orbits of comets.

Though the orbits of all comets are very eccentric ellipſes, there are vaſt differences among them; but excepting Mercury, there are no great differences among the planets either as to the eccentricity of their orbits, or the inclination of their planes; the planes of ſome comets are almoſt perpendicular to others, and ſome of their ellipſes are much wider than others. The narroweſt ellipſis of any comet hitherto obſerved was that of 1680. There is alſo a much greater inequality in the motion of the comets than of the planets; the velocity of the former being incomparably greater in their perihelion than in their aphelion; but the planets are but very little accelerated.

175 Opinions concerning their ſubſtance.

Aſtronomers are now generally agreed, that comets are opaque bodies, enlightened by the ſun. Hevelius, in a large work, wherein he gives the opinion of various

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ous authors on the ſubject, mentions ſome who were of the ſame ſentiments with himſelf, that comets were ſo far tranſparent as to let the light of the ſun paſs through them, which formed their tails. Sir Iſaac Newton was of opinion, that they are quite opaque; and in confirmation of this, he obſerves, that if a comet be ſeen in two parts of its orbit, at equal diſtances from the earth, but at unequal diſtances from the ſun, it always ſhines brighteſt in that neareſt the ſun. They are of very different magnitudes, which may be conjectured from their apparent diameter and brightneſs. Thus the head of a comet, when of the ſame brightneſs and apparent diameter with Saturn, may be ſuppoſed to be nearly about the ſame magnitude with that planet; though this muſt be attended with ſome uncertainty, as we know not whether the heads of comets reflect the ſun's light in the ſame manner the planets do. Their diſtance may be known from their parallax, in the manner related in a ſubſequent ſection.

176 Diſtances, diameters, &c. of ſome comets computed.

In this manner he found the diſtance of the comet of 1577 to be about 210 ſemidiameters of the earth, or about 840,000 miles diſtant from us, its apparent diameter being ſeven minutes; whence he concluded, that the true diameter of the comet was to that of the earth as 3 to 14. "But (ſays Dr Long) it was the atmoſphere of the comet which was then meaſured." Hevelius, from the parallax and apparent diameter of the head of the comet in 1652, computed its diameter to be to that of the earth as 52 to 100. By the ſame method he found the diameter of the head of the comet of 1664 to be at one time 12 ſemidiameters of the earth, and at another not much more than 5. "That the head of a comet muſt appear leſs the farther it is from the earth (ſays Dr Long) is obvious; but beſides this apparent change, there is alſo a real one in the dimenſions of the head of the ſame comet; for, when near the ſun, the atmoſphere is diminiſhed by the heat raiſing more of it into the tail; whereas, at a greater diſtance, the tail is diminiſhed and the head enlarged." Hevelius computed the diameter of the nucleus of the comets of 1661 and 1665 to be only about a tenth part of that of the earth; and Cyſatus makes the true diameter of the comet of 1618 to be about the ſame ſize. Some comets, however, from their apparent magnitude and diſtance, have been ſuppoſed much larger than the moon, or even equal in magnitude to ſome of the primary planets; and ſome have imagined, that by an interpoſition of theſe bodies betwixt the earth and ſun, we might account for thoſe darkneſſes which cannot be derived from any interpoſition of the moon. Such are thoſe mentioned by Herodotus, l. 7. c. 37. and l. 9. c. 70. likewiſe the eclipſe mentioned by Dion, which happened a little before the death of Auguſtus; and it is obſervable that Seneca ſaw a comet that year. Some have even attempted to account in this manner for the darkneſs which happened at our Saviour's crucifixion; and indeed it is certain, that were a comet in its perigee to come between the earth and ſun, and to be moving the ſame way with the earth, it muſt cauſe a darkneſs much more intenſe, as well as of more conſiderable duration, than what could take place in any lunar eclipſe.

177 Eclipſes occaſioned by comets.

178 Conjectures concerning their tails.

Various conjectures have been formed reſpecting the tails of comets; though it is acknowledged by all, that they depend on the ſun ſomehow or other; and for this plain reaſon, that they are always turned from him; but in what manner this is accompliſhed, we cannot eaſily determine. Apian, Tycho-Brache, and others, thought the tail was formed by the ſun's rays tranſmitted through the nucleus of the comet, which they fancied tranſparent, and was there refracted as in a lens of glaſs, ſo as to form a beam of light behind the comet: but this cannot be the caſe, as well becauſe the figure of a comet's tail does not anſwer to ſuch a refraction, as that ſuch refracted light would not be ſeen by a ſpectator placed ſideways to it, unleſs it fell upon ſome ſubſtance ſufficiently denſe to cauſe a reflexion. Des Cartes and his followers were of opinion, that the tail of a comet was owing to the refraction of its head: but if this were the caſe, the planets and principal fixed ſtars muſt have tails alſo; for the rays from them paſs through the ſame medium as the light from the comets. Sir Iſaac Newton was of opinion, that the tail of a comet is a very thin vapour which the head ſends out by reaſon of its heat: that it aſcends from the ſun juſt as ſmoke does from the earth: that as the aſcent of ſmoke is cauſed by the rarefaction of the air wherein it is entangled, cauſing ſuch air to aſcend and carry the ſmoke up with it; ſo the ſun's rays acting upon the coma or atmoſphere of the comet, do by rarefaction and refraction heat the ſame; that this heated atmoſphere heats, and by heating rarefies, the ether that is involved therein; and that the ſpecific gravity with which ſuch ether tends to the ſun, is ſo diminiſhed by its rarefaction, that will now aſcend from him by its relative lightneſs, and carry with it the reflecting particles whereof the tail is compoſed. Tho' the immenſely large tails of ſome comets ſeem to require a great quantity of matter to produce them, this is no objection to the foregoing ſolution: for every day's experience ſhows what a great quantity of ſmoke is produced from a very little wood or coal; and Newton has demonſtrated, that a cubic inch of air equally rarefied with that at the diſtance of a ſemidiameter from the earth's ſurface, would fill all the planetary regions to the orbit of Saturn and beyond. Mairan entertained a very different opinion. He ſuppoſed the tails of the comets to be formed out of the luminous matter whereof the ſun's atmoſphere conſiſts. This he ſuppoſes to extend as far as the orbit of the earth, and to furniſh matter for the aurora borealis. M. de la Lande is for joining the two laſt opinions together. Part of the matter which forms the tails of comets he ſuppoſes to ariſe from their own atmoſphere rarefied by heat and puſhed forward by the force of the light ſtreaming from the ſun; and alſo that a comet paſſing through the ſun's atmoſphere is drenched therein, and carries away ſome of it. Mr Rowning objects to Newton's account, that it can hardly be ſuppoſed the thin vapour of the tail ſhould go before the more ſolid body of the comet, when the motion thereof is ſometimes ſo extremely ſwift, as that of ſome of the comets is ſaid to be after the rate, as Sir Iſaac Newton calculated the motion of the comet of 1680 to be, of no leſs than 880,000 miles an hour. He therefore ſuppoſes the atmoſphere of the comet to extend every way round it as far as the tail reaches; and that the part of it which makes the tail is diſtinguiſhed from the reſt, ſo as to fall thick upon that part of the atmoſphere which goes before the comet in its progreſs along its elliptic orbit.

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179 Opinion of Des Cartes.

The

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The greateſt objection to this is the immenſe magnitude of the atmoſpheres; as it muſt now be ſuppoſed to account for the vaſt lengths of the tails of ſome comets, which have been ſaid to meaſure above 80 millions of miles.

The many diſcoveries which, ſince the time of Newton, Halley, and other celebrated mathematicians, have been made in electricity, having brought in a new element unknown to former ages, and which ſhows a vaſt power through every part of the creation with which we are acquainted, it became natural to imagine that it muſt extend alſo into thoſe higher regions which are altogether inacceſſible to man. The ſimilarity of the tails of comets to the aurora borealis, which is commonly looked upon to be an electrical phenomenon, therefore ſuggeſted an opinion at preſent far from being generally diſbelieved, that the tails of comets are ſtreams of electric matter. An hypotheſis of this kind was publiſhed by Dr Hamilton of Dublin in a ſmall treatiſe, entitled, *Conjectures on the Nature of the Aurora Borealis, and on the Tails of Comets.* His hypotheſis is, that the comets are of uſe to bring back the electric fluid to the planets, which is continually diſcharged from the higher regions of their atmoſpheres. Having given at length the abovementioned opinion of Sir Iſaac, "We find (ſays he) in this account, that Sir Iſaac aſcribes the aſcent of comets tails to their being rarer and lighter, and moving round the ſun more ſwiftly, than the ſolar atmoſphere, with which he ſuppoſes them to be ſurrounded whilſt in the neighbourhood of the ſun; he ſays alſo, that whatever poſition (in reſpect to each other) the head and tail of a comet then receive, they will keep the ſame afterwards moſt freely; and in another place he obſerves, 'That the celeſtial ſpaces muſt be entirely void of any power of reſiſting, ſince not only the ſolid bodies of the planets and comets, but even the exceeding thin vapours of which comets tails are formed, move thro' thoſe ſpaces with immenſe velocity, and yet with the greateſt freedom.' I cannot help thinking that this account is liable to many difficulties and objections, and that it ſeems not very conſiſtent with itſelf or with the phenomena.

180 Dr Hamilton of Dublin's opinion.

"I do not know that we have any proof of the exiſtence of a ſolar atmoſphere of any conſiderable extent, nor are we any where taught how to gueſs at the limits of it. It is evident that the exiſtence of ſuch an atmoſphere cannot be proved merely by the aſcent of comets tails from the ſun, as that phenomenon may poſſibly ariſe from ſome other cauſe. However, let us ſuppoſe for the preſent, that the aſcent of comets tails is owing to an atmoſphere ſurrounding the ſun, and ſee how the effects ariſing from thence will agree with the phenomena. When a comet comes into the ſolar atmoſphere, and is then deſcending almoſt directly to the ſun, if the vapours which compoſe the tail are raiſed up from it by the ſuperior denſity and weight of that atmoſphere, they muſt riſe into thoſe parts that the comet has left, and therefore at that time they may appear in a direction oppoſite to the ſun. But as ſoon as the comet comes near the ſun, and moves in a direction nearly at right angles with the direction of its tail, the vapours which then ariſe, partaking of the great velocity of the comet, and being ſpecifically lighter than the medium in which they move, and being vaſtly expanded through it, muſt neceſſarily ſuffer a reſiſtance immenſely greater than what the ſmall and denſe body of the comet meets with, and conſequently cannot poſſibly keep up with it, but muſt be left behind, or, as it were, driven backwards by the reſiſtance of that medium into a line directed towards the parts which the comet has left, and therefore can no longer appear in a direction oppoſite to the ſun. And, in like manner, when a comet paſſes its perihelion, and begins to aſcend from the ſun, it certainly ought to appear ever after with its tail behind it, or in a direction pointed towards the ſun; for if the tail of the comet be ſpecifically lighter than the medium in which it moves with ſo great velocity, it muſt be juſt as impoſſible it ſhould move foremoſt, as it is that a torch moved ſwiftly thro' the air ſhould project its flame and ſmoke before it. Since therefore we find that the tail of a comet, even when it is aſcending from the ſun, moves foremoſt, and appears in a direction nearly oppoſite to the ſun, I think we muſt conclude that the comet and its tail do not move in a medium heavier and denſer than the matter of which the tail conſiſts, and conſequently that the conſtant aſcent of the tail from the ſun muſt be owing to ſome other cauſe. For that the ſolar atmoſphere ſhould have denſity and weight ſufficient to raiſe up the vapours of a comet from the ſun, and yet not be able to give any ſenſible reſiſtence to theſe vapours in their rapid progreſs through it, are two things inconſiſtent with each other: And therefore, ſince the tail of a comet is found to move as freely as the body does, we ought rather to conclude, that the celeſtial ſpaces are void of all reſiſting matter, than that they are filled with a ſolar atmoſphere, be it ever ſo rare.

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"But there is, I think, a further conſideration, which will ſhow that the received opinion, as to the aſcent of comets tails, is not agreeable to the phenomena, and may at the ſame time lead us to ſome knowledge of the matter of which theſe tails conſiſt; which I ſuſpect is of a very different nature from what it has been hitherto ſuppoſed to be. Sir Iſaac ſays, the vapours, of which the tail of a comet conſiſts, grow hot by reflecting the rays of the ſun, and thereby warm and rarefy the medium which ſurrounds them; which muſt therefore aſcend from the ſun, and carry with it the reflecting particles of which the tail is formed; for he always ſpeaks of the tail as ſhining by reflected light. But one would rather imagine, from the phenomena, that the matter which forms a comet's tail has not the leaſt ſenſible power of reflecting the rays of light. For it appears from Sir Iſaac's obſervation, which I have quoted already, that the light of the ſmalleſt ſtars, coming to us through the immenſe thickneſs of a comet's tail, does not ſuffer the leaſt diminution. And yet, if the tail can reflect the light of the ſun ſo copiouſly as it muſt do if its great ſplendor be owing to ſuch reflection, it muſt undoubtedly have the ſame effect on the light of the ſtars; that is, it muſt reflect back the light which comes from the ſtars behind it, and by ſo doing muſt intercept them from our ſight, conſidering its vaſt thickneſs, and how exceedingly ſlender a ray is that comes from a ſmall ſtar; or if it did not intercept their whole light, it muſt at leaſt increaſe their twinkling. But we do not find that it has even this ſmall effect: for thoſe ſtars that appear through the tail are not obſerved to twinkle more than

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others in their neighbourhood. Since therefore this fact is supported by observations, what can be a plainer proof that the matter of a comet's tail has no power of reflecting the rays of light? and consequently that it must be a self-shining substance. But the same thing will further appear, from considering that bodies reflect and refract light by one and the same power; and therefore if comets tails want the power of refracting the rays of light, they must also want the power of reflecting them. Now, that they want this refracting power appears from hence: If that great column of transparent matter which forms a comet's tail, and moves either in a vacuum or in some medium of a different density from its own, had any power of refracting a ray of light coming through it from a star to us, that ray must be turned far out of its way in passing over the great distance between the comet and the earth; and therefore we should very sensibly perceive the smallest refraction that the light of the stars might suffer in passing through a comet's tail. The consequence of such a refraction must be very remarkable: the stars that lie near the tail would, in some cases, appear double; for they would appear in their proper places by their direct rays, and we should see their images behind the tail, by means of their rays which it might refract to our eyes; and those stars that were really behind the tail would disappear in some situations, their rays being turned aside from us by refraction. In short, it is easy to imagine what strange alterations would be made in the apparent places of the fixed stars by the tails of comets, if they had a power of refracting their light, which could not fail to be taken notice of if any such ever happened. But since astronomers have not mentioned any such apparent changes of place among the stars, I take it for granted that the stars seen through all parts of a comet's tail appear in their proper places, and with their usual colours; and consequently I infer, that the rays of light suffer no refraction in passing through a comet's tail. And thence I conclude (as before), that the matter of a comet's tail has not the power of refracting or reflecting the rays of light, and must therefore be a lucid or self-shining substance."

181 Sir Isaac's account defended.

But whatever probability the Doctor's conjecture concerning the materials whereof the tails are formed may have in it, his criticism on Sir Isaac Newton's account of them seems not to be just: for that great philosopher supposes the comets to have an atmosphere peculiar to themselves; and consequently, in their nearest approaches to the sun, both comet and atmosphere are immersed in the atmosphere of that luminary. In this case, the atmosphere of the comet being prodigiously heated on the side next to the sun, and consequently the equilibrium in it broken, the denser parts will continually pour in from the regions fartherst from the sun; for the same reason, the more rarefied part which is before will continually fly off opposite to the sun, being displaced by that which comes from behind; for tho' we must suppose the comet and its atmosphere to be heated on all sides to an extreme degree, yet still that part which is fartherst from the sun will be less hot, and consequently more dense, than what is nearest to his body. The consequence of this is, that there must be a constant stream of dense atmosphere descending towards the sun, and another stream of rarefied vapours and atmosphere ascending on the contrary side; just as, in a common fire, there is a constant stream of dense air descending, which pushes up another of rarefied air, flame, and smoke. The resistance of the solar atmosphere may indeed be very well supposed to occasion the curvature observable in the tails of comets, and their being better defined in the fore part than behind; and this appearance we think Dr Hamilton's hypothesis is incapable of solving. We grant, that there is the utmost probability that the tails of comets are streams of electric matter; but they who advance a theory of any kind ought to solve every phenomenon, otherwise their theory is insufficient. It was incumbent on Dr Hamilton, therefore, to have explained how this stream of electric matter comes to be bent into a curve; and also why it is better defined and brighter on the outer side of the arch than on the inner. This, indeed, he attempts in the following manner: "But that this curvature was not owing to any resisting matter appears from hence, that the tail must be bent into a curve though it met with no resistance; for it could not be a right line, unless all its particles were projected in parallel directions, and with the same velocity, and unless the comet moved uniformly in a right line. But the comet moves in a curve, and each part of the tail is projected in a direction opposite to the sun, and at the same time partakes of the motion of the comet; so that the different parts of the tail must move on in lines which diverge from each other; and a line drawn from the head of a comet to the extremity of the tail, will be parallel to a line drawn from the sun to the place where the comet was when that part of the tail began to ascend, as Sir Isaac observes; and so all the chords or lines drawn from the head of the comet to the intermediate parts of the tail, will be respectively parallel to lines drawn from the sun to the places where the comet was when these parts of the tail began to ascend. And therefore, since these chords of the tail will be of different lengths, and parallel to different lines, they must make different angles, with a great circle passing through the sun and comet, and consequently a line passing through their extremities will be a curve.

Conclusions from the foregoing Appearances.

182 Dr Hamilton's hypothesis insufficient.

"It is observed, that the convex side of the tail which is turned from the sun is better defined, and shines a little brighter, than the concave side. Sir Isaac accounts for this, by saying, that the vapour on the convex side is fresher (that is, has ascended later) than that on the concave side; and yet I cannot see how the particles on the convex side can be thought to have ascended later than those on the concave side which may be nearer to the head of the comet. I think it rather looks as if the tail, in its rapid motion, met with some slight resistance just sufficient to cause a small condensation in that side of it which moves foremost, and which would occasion it to appear a little brighter and better defined than the other side; which slight resistance may arise from that subtile ether which is supposed to be dispersed through the celestial regions, or from this very electric matter dispersed in the same manner, if it be different from the ether."

On the last part of this observation we must remark, that though a slight resistance in the etherial medium would have served Sir Isaac Newton's turn, it will by no means serve Dr Hamilton's; for though a stream of

water

Conclusions from the foregoing Appearances.

water or air may be eaſily deſtroyed or broken by reſiſtance, yet a ſtream of electric matter ſeems to ſet every obſtacle at defiance. If a ſharp needle is placed on the conductor of an electric machine, and the machine ſet in motion, we will perceive a ſmall ſtream of electric matter iſſuing from the point; but though we blow againſt this ſtream of fire with the utmoſt violence, it is impoſſible either to move it, or to brighten it on the ſide againſt which we blow. If the celeſtial ſpaces then are full of a ſubtile ether capable of thus affecting a ſtream of electric matter, we may be ſure that it alſo will reſiſt very violently: and we are then as much difficulted to account for the projectile motion continuing amidſt ſuch violent reſiſtance; for if the ether reſiſts the tail of the comet, it is impoſſible to prove that it doth not reſiſt the head alſo.

183 Electric matter not always paſſive.

This objection may appear to ſome to be but weakly founded, as we perceive the electric fluid to be endowed with ſuch extreme ſubtility, and to yield to the impreſſion of ſolid bodies with ſuch facility, that we eaſily imagine it to be of a very paſſive nature in all caſes. But it is certain, that this fluid only ſhows itſelf paſſive where it paſſes from one body into another, which it ſeems very much inclined to do of itſelf. It will be alſo found, on proper examination of all the phenomena, that the only way we can manage the electric fluid at all is by allowing it to direct its own motions. In all caſes where we ourſelves attempt to aſſume the government of it, it ſhows itſelf the moſt untractable and ſtubborn being in nature. But theſe things come more properly under the article ELECTRICITY, where they are fully conſidered. Here it is ſufficient to obſerve, that a ſtream of electric matter reſiſts air, and from the phenomena of electric repulſion we are ſure that one ſtream of electric matter reſiſts another; from which we may be alſo certain, that if a ſtream of electric matter moves in an aerial fluid, ſuch fluid will reſiſt it: and we can only judge of the degree of reſiſtance it meets with in the heavens from what we obſerve on earth. Here we ſee the moſt violent blaſt of air has no effect upon a ſtream of electric fluid; in the celeſtial regions, either air or ſome other fluid has an effect upon it according to Dr Hamilton. The reſiſtance of that fluid, therefore, muſt be greater than that of the moſt violent blaſt of air we can imagine.

As to the Doctor's method of accounting for the curvature of the comet's tail, it might do very well on Sir Iſaac Newton's principles, but cannot do ſo on his. There is no compariſon between the celerity with which rarefied vapour aſcends in our atmoſphere, and that whereby the electric fluid is diſcharged. The velocity of the latter ſeems to equal that of light; of conſequence, ſuppoſing the velocity of the comet to be equal to that of the earth in its annual courſe, and its tail equal in length to the diſtance of the ſun from the earth, the curvature of the tail could only be to a ſtraight line as the velocity of the comet in its orbit is to the velocity of light, which, according to the calculations of Dr Bradley, is as 10,201 to 1. The apparent curvature of ſuch a comet's tail, therefore, would at this rate only be $\frac{1}{10201}$ part of its viſible length, and thus would always be imperceptible to us. The velocity of comets is indeed ſometimes inconceivably great. Mr Brydone obſerved one at Palermo, in July 1770, which in 24 hours deſcribed an arch in the heavens upwards of 50 degrees in length; according to which he ſuppoſes, that if it was as far diſtant as the ſun, it muſt have moved at the rate of upwards of 60 millions of miles in a day. But this comet was attended with no tail, ſo that we cannot be certain whether the curvature of the tails of theſe bodies correſponds with their velocity or not.

184 Prodigious velocity of a comet obſerved by Mr Brydone.

Conclusions from the foregoing Appearances.

The near approach of ſome comets to the ſun ſubjects them to intenſe and inconceivable degrees of heat. Newton calculated that the heat of the comet of 1680 muſt have been near 2000 times as great as that of red hot iron. The calculation is founded upon this principle, that the heat of the ſun falling upon any body at different diſtances is reciprocally as the ſquares of thoſe diſtances; but it may be obſerved, that the effect of the heat of the ſun upon all bodies near our earth depends very much on the conſtitution of thoſe bodies, and of the air that ſurrounds them. "The comet in queſtion (ſays Dr Long) certainly acquired a prodigious heat; but I cannot think it came up to what the calculation makes it: the effect of the ſtrongeſt burning-glaſs that has ever been made uſe of was the vitrification of moſt bodies placed in its focus. What would be the effect of a ſtill greater heat we can only conjecture; it would perhaps ſo diſunite the parts as to make them fly off every way in atoms. This comet, according to Halley, in paſſing thro' its ſouthern node, came within the length of the ſun's ſemidiameter of the orbit of the earth. Had the earth then been in the part of her orbit neareſt to that node, their mutual gravitation muſt have cauſed a change in the plane of the orbit of the earth, and in the length of our year: he adds, that if ſo large a body with ſo rapid a motion as that of this comet were to ſtrike againſt the earth, a thing by no means impoſſible, the ſhock might reduce this beautiful frame to its original chaos."

185 Vehement heat of the comet of 1680.

We muſt not conclude this account without obſerving, that Whiſton, who, from Flamſtead's meaſure of its apparent diameter, concluded the nucleus of the comet to be about ten times as big as the moon, or equal to a fourth part of the earth, attributes the univerſal deluge in the time of Noah to the near approach thereof. His opinion was, that the earth paſſing thro' the atmoſphere of the comet, attracted therefrom great part of the water of the flood; that the nearneſs of the comet raiſed a great tide in the ſubterraneous waters, ſo that the outer cruſt of the earth was changed from a ſpherical to an oval figure; that this could not be done without making fiſſures and cracks in it, thro' which the waters forced themſelves by the hollow of the earth being changed into a leſs capacious form; that along with the water thus ſqueezed up on the ſurface of the earth, much ſlime or mud would riſe; which, together with the groſſer part of the comet's atmoſphere, would after the ſubſiding of the water, partly into the fiſſures and partly into the lower parts of the earth to form the ſea, cover all over, to a conſiderable depth, the antediluvian earth. Thus he accounts for trees and bones of animals being found at very great depths in the earth. He alſo held that, before the fall, the earth revolved round the ſun in the plane of the ecliptic, keeping always the ſame points of its ſurface towards the ſame fixed ſtars. By this means, as every meridian would come to the ſun but once in every revolution, a day and a year were then the ſame: but

Conclusions from the foregoing Appearances.

that a comet ſtriking obliquely upon ſome part of the earth gave it the diurnal rotation; that the antediluvian year conſiſted of 360 days; but that the additional matter depoſited upon the earth from the atmoſphere of the comet at the flood ſo retarded the revolution thereof round the ſun, that it is not now performed in leſs than 365 days and about a quarter. The ſame comet he thought would probably, coming near the earth when heated in an immenſe degree in its perihelion, be the inſtrumental cauſe of that great cataſtrophe, the general conflagration, foretold in the ſacred writings and from ancient tradition.

186 Conjectures of Hevelius, &c. concerning the nature of comets.

Theſe conjectures lead us to ſpeak ſomewhat more particularly concerning the nature of the comets, and the purpoſes they may poſſibly anſwer in the creation. Hevelius, in order to account for the various appearances of the nucleus already related, ſuppoſed that they were compoſed of ſeveral maſſes compacted together with a tranſparent fluid interſperſed, but the apparent changes in the nucleus may be only on the ſurface: comets may be ſubject to ſpots as the planets are; and the vaſtly different degrees of heat they go through may occaſion great and ſudden changes, not only in their ſurfaces, but even in their internal frame and texture. Newton places all theſe apparent changes to the atmoſphere that environs them; which muſt be very denſe near the ſurface, and have clouds floating therein. It was his opinion, that the changes mentioned may all be in the clouds, not in the nucleus. This laſt indeed he looked upon to be a body of extreme ſolidity, in order to ſuſtain ſuch an intenſe heat as the comets are ſometimes deſtined to undergo; and that, notwithſtanding their running out into the immenſe regions of ſpace, where they were expoſed to the moſt intenſe degrees of cold, they would hardly be cooled again on their return to the ſun. Indeed, according to his calculation, the comet of 1680 muſt be for ever in a ſtate of violent ignition. He hath computed that a globe of red-hot iron of the ſame dimenſions with the earth, would ſcarce be cool in 50,000 years. If then the comet be ſuppoſed to cool 100 times faſter than red-hot-iron, as its heat was 2000 times greater, it muſt require upwards of a million of years to cool it. In the ſhort period of 575 years, therefore, its heat will be in a manner ſcarce diminiſhed; and, of conſequence, in its next and every ſucceeding revolution, it muſt acquire an increaſe of heat: ſo that, ſince the creation, having received a proportional addition in every ſucceeding revolution, it muſt now be in a ſtate of ignition very little inferior to that of the ſun itſelf. Sir Iſaac Newton hath farther concluded, that this comet muſt be conſiderably retarded in every ſucceeding revolution by the atmoſphere of the ſun within which it enters; and thus muſt continually come nearer and nearer his body, till at laſt it falls into it. This, he thinks, may be one uſe of the comets, to furniſh fuel for the ſun, which otherwiſe would be in danger of waſting from the continual emiſſion of its light.

He adds, that for the conſervation of the water and moiſture of the planets, comets ſeem abſolutely requiſite; from whoſe condenſed vapours and exhalation all the moiſture which is ſpent in vegetation and putrefaction, and turned into dry earth, &c. may be reſupplied and recruited; for all vegetables grow and increaſe wholly from fluids; and again, as to their greateſt part, turn by putrefaction into earth; an earthy ſlime being perpetually precipitated to the bottom of putrefying liquors. Hence the quantity of dry earth muſt continually increaſe, and the moiſture of the globe decreaſe, and be quite evaporated, if it have not a continual ſupply from ſome part or other of the univerſe. "And I ſuſpect (adds our great author), that the ſpirit, which makes the fineſt, ſubtileſt, and beſt part of our air, and which is abſolutely requiſite for the life and being of all things, comes principally from the comets."

Conclusions from the foregoing Appearances.

187 Mr Brydone's conjectures concerning comets without tails.

Mr Brydone obſerves, that the comets without tails ſeem to be of a very different ſpecies from thoſe which have tails: To the latter, he ſays, they appear to bear a much leſs reſemblance than they do even to planets. He tells us, that comets with tails have ſeldom been viſible but on their receſs from the ſun: that they are kindled up, and receive their alarming appearance, in their near approach to this glorious luminary; but that thoſe without tails are ſeldom or never ſeen but on their way to the ſun; and he does not recollect any whoſe return has been tolerably well aſcertained. "I remember indeed (ſays he), a few years ago, a ſmall one, that was ſaid to have been diſcovered by a teleſcope after it had paſſed the ſun, but never more became viſible to the naked eye. This aſſertion is eaſily made, and nobody can contradict it; but it does not at all appear probable that it ſhould have been ſo much leſs luminous after it had paſſed the ſun than before it approached him: and I will own to you, when I have heard that the return of theſe comets had eſcaped the eyes of the moſt acute aſtronomers, I have been tempted to think that they did not return at all, but were abſorbed in the body of the ſun, which their violent motion towards him ſeemed to indicate." He then attempts to account for the continual emiſſion of the ſun's light without waſte, by ſuppoſing that there are numberleſs bodies throughout the univerſe that are attracted into the body of the ſun, which ſerve to ſupply the waſte of light, and which for ſome time remain obſcure and occaſion ſpots on his ſurface, till at laſt they are perfectly diſſolved and become bright like the reſt. This hypotheſis may account for the dark ſpots becoming as bright, or even brighter, than the reſt of the diſk, but will by no means account for the brighter ſpots becoming dark. Of this comet too, Mr Brydone remarks, that it was evidently ſurrounded by an atmoſphere which refracted the light of the fixed ſtars, and ſeemed to cauſe them change their places as the comet came near them.

188 Mr Cole's hypotheſis.

A very ſtrange opinion we find ſet forth in a book entitled "Obſervations and Conjectures on the Nature and Properties of Light, and on the Theory of Comets, by William Cole." This gentleman ſuppoſes that the comets belong to no particular ſyſtem; but were originally projected in ſuch directions as would ſucceſſively expoſe them to the attraction of different centres, and thus they would deſcribe various curves of the parabolic and the hyperbolic kind. This treatiſe is written in anſwer to ſome objections thrown out in Mr Brydone's Tour, againſt the motions of the comets by means of the two forces of gravitation and projection, which

ASTRONOMY

Plate LXIX

Fig. 88

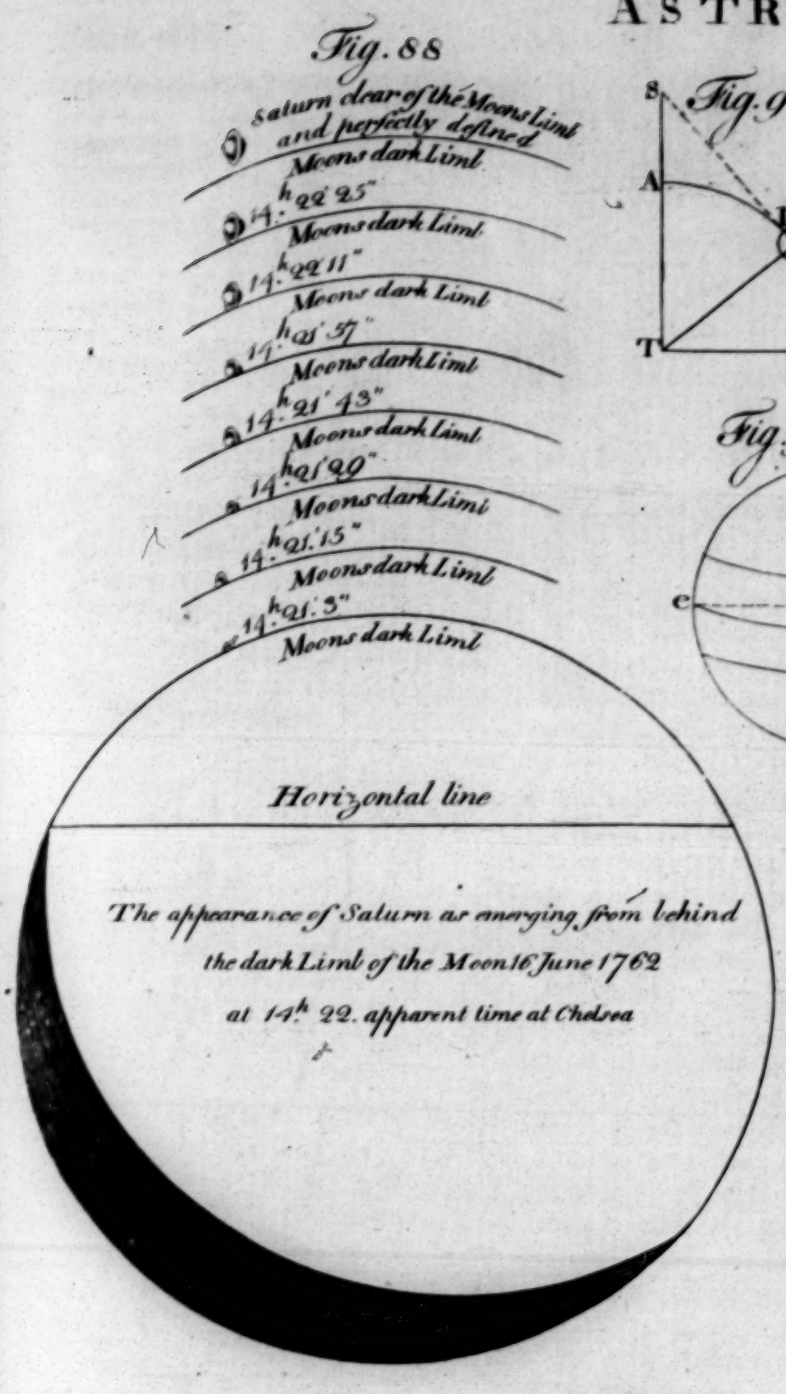

Fig. 90

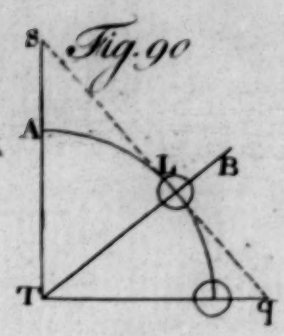

Fig. 89

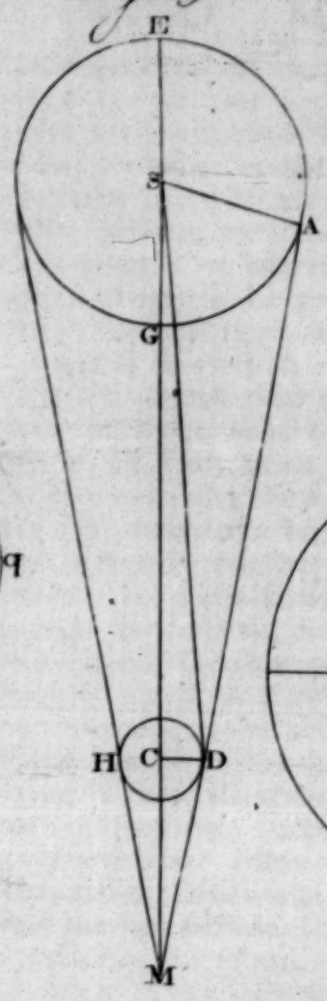

Fig. 92

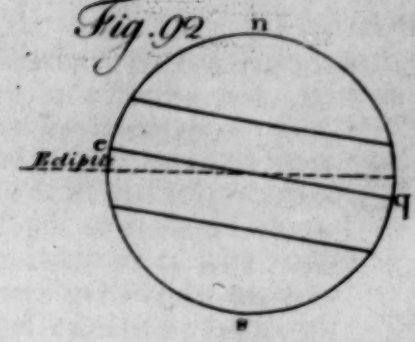

Fig. 93

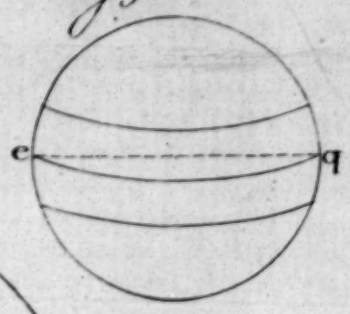

Fig. 96

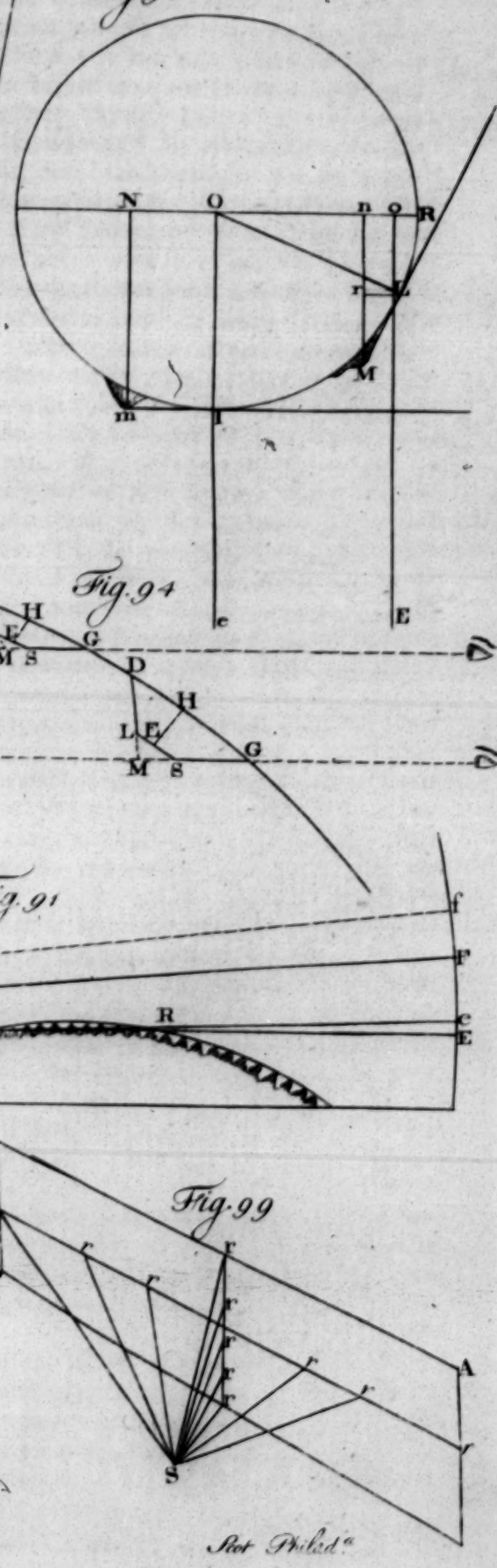

Fig. 94

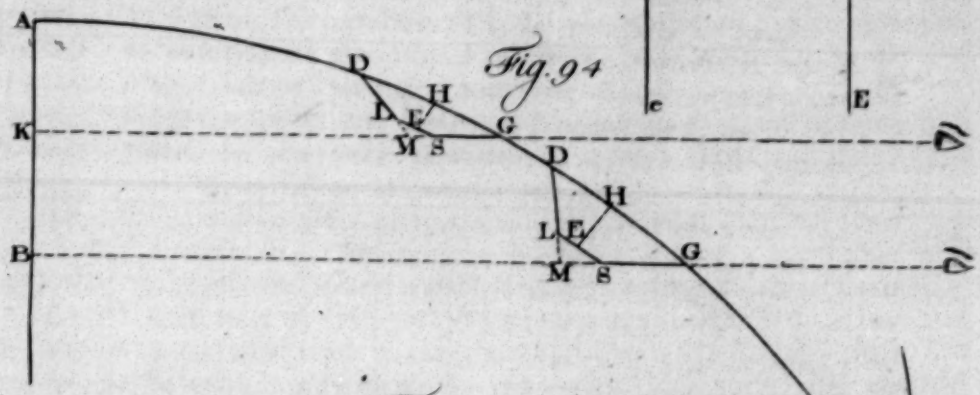

Fig. 95

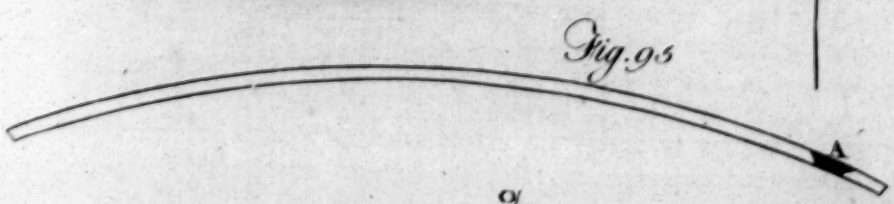

Fig. 91

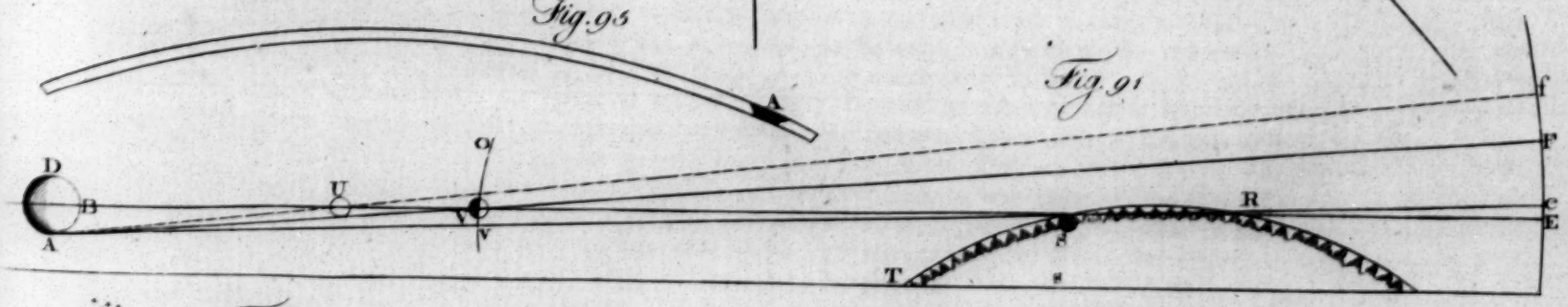

Fig. 98

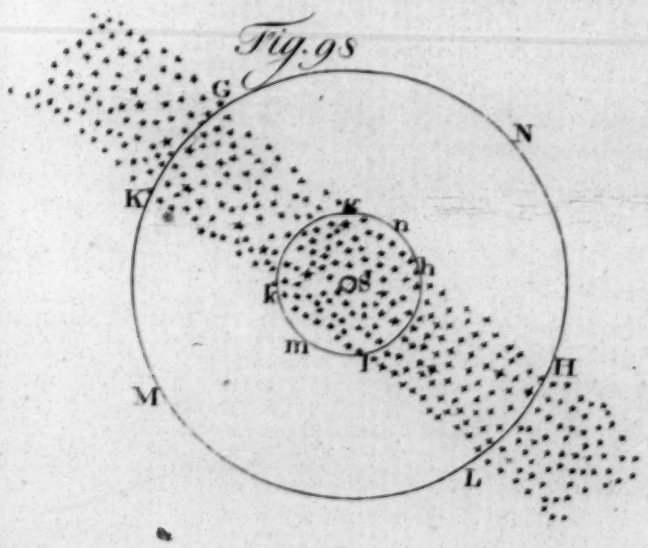

Fig. 97

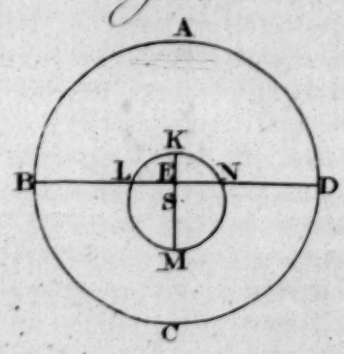

Fig. 99

Rect Pulsd.

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Conclusions from the foregoing Appearances.

which were thought ſufficient for that purpoſe by Sir Iſaac Newton; of which we ſhall treat as fully as our limits will allow in the next ſection.

189 Of the periodical times, &c. of the comets.

The analogy between the periodical times of the planets and their diſtances from the ſun diſcovered by Kepler, takes place alſo in the comets. In conſequence of this, the mean diſtance of a comet from the ſun may be found by comparing its period with the time of the earth's revolution round the ſun. Thus the period of the comet that appeared in 1531, 1607, 1682, and 1759, being about 76 years, its mean diſtance from the ſun may be found by this proportion: As 1, the ſquare of one year, the earth's periodical time, is to 5776 the ſquare of 76, the comet's periodical time; ſo is 1,000,000, the cube of 100 the earth's mean diſtance from the ſun, to 5,776,000,000, the cube of the comet's mean diſtance. The cube root of this laſt number is 1794, the mean diſtance itſelf in ſuch parts as the mean diſtance of the earth from the ſun contains 100. If the perihelion diſtance of this comet, 58, be taken from 3588 double the mean diſtance, we ſhall have the aphelion diſtance, 3530, of ſuch parts as the diſtance of the earth contains 100; which is a little more than 35 times the diſtance of the earth from the ſun. By a like method, the aphelion diſtance of the comet of 1680 comes out 138 times the mean diſtance of the earth from the ſun, ſuppoſing its period to be 575 years; ſo that this comet in its aphelion, goes more than 14 times the diſtance from the ſun that Saturn does. Euler computes the orbit of this comet from three of Flamſtead's obſervations taken near together, compared with a fourth taken at ſome diſtance from the other three; and from thence concludes the period to be a little more than 170 years. "It ſeems ſomething ſurpriſing (ſays Dr Long), that, from the ſame obſervations which were uſed by Newton and Halley, he ſhould bring out a period ſo very different from what thoſe great men have determined: but it is the leſs to be wondered at, if we conſider how ſmall a portion of the comet's orbit lay between the moſt diſtant places uſed in this computation, or indeed that could be had for that purpoſe; ſo ſmall, that the form of the ellipſis cannot be found with preciſion by this method, except the comet's places were more exactly verified than is poſſible to be done: and that he does not pretend to confirm his determination of the period by pointing out and comparing together any former appearances of this comet; a method which Newton recommended as the only one whereby the periodical times and tranſverſe diameters of the orbits of the comets can be determined with accuracy."

The period of the comet in 1744 is much longer than even that of 1680. Mr Betts, in attempting to compute the tranſverſe axis of its orbit, found it come out ſo near infinite, that, though the orbit ſhowed itſelf in this manner to be a very long one, he found it impoſſible to calculate it without ſome obſervations made after its perihelion. Halley, after he had finiſhed his table of comets, found ſuch a ſimilitude in the elements of thoſe of 1531, 1607, and 1682, that he was induced to believe them to be returns of the ſame comet in an elliptic orbit: but as there was ſuch a difference in their periodical times and inclinations of their orbits as ſeemed to make againſt this opinion; and as the obſervations of the firſt of them in 1531 by Apian, and the ſecond in 1607 by Kepler were not exact enough to determine ſo nice a point when he firſt publiſhed his ſynopſis in 1705; he only mentioned this as a thing probable, and recommended it to poſterity to watch for an appearance of the ſame in 1758. Afterwards, looking over the catalogue of ancient comets, and finding three others at equal intervals with thoſe now mentioned, he grew more poſitive in his opinion; and knowing a method of calculating with eaſe a motion in an elliptic orbit, how eccentric ſoever it might be, inſtead of the parabolic orbit which he had given for the comet of 1682, he ſet about adapting the plan of that orbit to an ellipſis of a given ſpace and magnitude, having the ſun in one of its foci, ſo as to tally with the obſervations of that comet made by Flamſtead with great accuracy, by the help of a very large ſextant. He likewiſe corrected the places of the comet of 1531 from Apian, and thoſe of the comet 1607 from Kepler and Longomontanus, by rectifying the places of the ſtars they had made uſe of, and found thoſe places agree as well with the motion in ſuch an ellipſis as could be expected from the manner of obſerving of theſe aſtronomers and the imperfections of their inſtruments. The greateſt objection to this theory was ſome difference in the inclination of the orbits, and that there was above a year's difference between the two periods. The comet of 1531 was in its perihelion Auguſt 24.; that of 1607, October 16.; and that of 1682, September 4.: ſo that the firſt of theſe periods was more than 76, the latter not quite 75 years. To obviate this, he reminds his readers of an obſervation made by him of the periodical revolution of Saturn having at one time been about 13 days longer than at another time; occaſioned, as he ſuppoſed, by the near approach of Saturn and Jupiter, and the mutual attraction and gravitation of the two planets: and obſerves, that in the ſummer of the year 1681, the comet in its deſcent was for ſome time ſo near Jupiter, that its gravitation towards that planet was one-fiftieth part of its gravitation towards the ſun. This, he concluded, would cauſe a change in the inclination of its orbit, and alſo in the velocity of its motion: for by continuing longer near the planet Jupiter on the ſide moſt remote from the ſun, its velocity, would be more increaſed by the joint forces of both thoſe bodies, than it would be diminiſhed by them acting contrarywiſe, when on the ſide next to the ſun where its motion was ſwifteſt. The projectile motion being thus increaſed, its orbit would be enlarged, and its period lenghtened; ſo that he thought it probable it would not return till after a longer period than 76 years, about the end of the year 1758 or beginning of 1759.

190 Dr Halley calculates the return of comets.

As Halley expreſſed his opinon modeſtly, though clearly enough, that this comet would appear again about the end of 1758, or the beginning of the following year, M. de la Lande pretends he muſt have been at a loſs to know whether the period he foretold would have been of 75 or of 76 years; that he did not give a deciſive prediction, as if it had been the reſult of calculation; and that, by conſidering the affair in ſo looſe a manner as Halley did, there was a good deal of room for objecting to his reaſoning. After theſe reflections, he is very large in his commendation of the performance of Mr Clairault; who, he ſays, not only

Conclusions from the foregoing Appearances

191 Why the periodical return of comets may happen at unequal intervals.

Conclusions from the foregoing Appearances.

only calculated ſtrictly the effect of the attraction of Jupiter in 1681 and 1683, when the comet was again near Jupiter, but did not neglect the attraction of that planet when the comet was moſt diſtant; that he conſidered the uninterrupted attractions of Jupiter and Saturn upon the ſun and upon the comet, but chiefly the attraction of Jupiter upon the ſun, whereby that luminary was a little diſplaced, and gave different elements to the orbit of the comet. By this method he found the comet would be in its perihelion about the middle of April: but that, on account of ſome ſmall quantities neceſſarily neglected in the method of approximation made uſe of by him, Mr. Clairault deſired to be indulged one month; and that the comet came juſt 30 days before the time he had fixed for its appearance.

That comets may have their motion diſturbed by the planets, eſpecially by the two largeſt, Jupiter and Saturn, appears by an inſtance juſt now mentioned. They may alſo affect one another by their mutual gravitation when out of the planetary regions; but of this we can take no account, nor can we eſtimate the reſiſtance of the ether through which they paſs; and yet both theſe cauſes may have ſome influence on the inclination of their orbits and the length of their periods.

192 Fixed ſtars ſuppoſed to be ſuns.

THUS much concerning the bodies of which our ſolar ſyſtem is compoſed. But the conjectures of aſtronomers have reached even beyond its boundaries: they have ſuppoſed every one of the innumerable multitude of fixed ſtars to be a ſun attended by planets and comets, each of which is an habitable world like our own; ſo that the univerſe may in ſome meaſure be repreſented by fig. 161. where ſeveral adjacent ſyſtems are marked. The ſtrongeſt argument for this hypotheſis is, that they cannot be magnified by a teleſcope on account of their extreme diſtance; whence we muſt conclude that they ſhine by their own light, and are therefore as many ſuns; each of which we may ſuppoſe to be equal, if not ſuperior, in luſtre and magnitude to our own. They are not ſuppoſed to be at equal diſtances from us, but to be more remote in proportion to their apparent ſmallneſs. This ſuppoſition is neceſſary to prevent any interference of their planets; and thus there may be as great a diſtance between a ſtar of the firſt magnitude and one of the ſecond apparently cloſe to it, as between the earth and the fixed ſtars firſt mentioned.

193 Oppoſed, from the variable nature of the ſtars.

Thoſe who take the contrary ſide of the queſtion affirm, that the diſappearance of ſome of the fixed ſtars is a demonſtration that they cannot be ſuns, as it would be to the higheſt degree abſurd to think that God would create a ſun which might diſappear of a ſudden, and leave its planets and their inhabitants in endleſs night. Yet this opinion we find adopted by Dr Keill, who tells us, "It is no ways improbable that theſe ſtars loſt their brightneſs by a prodigious number of ſpots which entirely covered and overwhelmed them. In what diſmal condition muſt their planets remain, who have nothing but the dim and twinkling light of the fixed ſtars to enlighten them?" Others, however, have made ſuppoſitions more agreeable to our notions of the benevolent character of the Deity. Sir Iſaac Newton thinks that the ſudden blaze of ſome ſtars may have been occaſioned by the falling of a comet into them, by which means they would be enabled to emit a prodigious light for a little time, after which they would gradually return to their former ſtate. Others have thought that the variable ones, which diſappear for a time, were planets, which were only viſible during ſome part of their courſe. But this their apparent immobility, notwithſtanding their decreaſe of luſtre, will not allow us to think. Some have imagined, that one ſide of them might be naturally much darker than the other, and when by the revolution of the ſtar upon its axis the dark ſide was turned towards us, the ſtar became inviſible, and, for the ſame reaſon, after ſome interval, reſumed its former luſtre. M. Maupertuis, in his diſſertation on the figures of the celeſtial bodies (p. 61—63.), is of opinion, that ſome ſtars, by their prodigious quick rotations on their axes, may not only aſſume the figures of oblate ſpheroids, but that, by the great centrifugal force ariſing from ſuch rotations, they may become of the figures of mill-ſtones; or be reduced to flat circular planes, ſo thin as to be quite inviſible when their edges are turned towards us; as Saturn's ring is in ſuch poſitions. But when very eccentric planets or comets go round any flat ſtar, in orbits much inclined to its equator, the attraction of the planets or comets in their perihelions muſt alter the inclination of the axis of that ſtar; on which account it will appear more or leſs large and luminous, as its broad ſide is more or leſs turned towards us. And thus he imagines we may account for the apparent changes of magnitude and luſtre in thoſe ſtars, and likewiſe for their appearing and diſappearing.

Conclusions from the foregoing Appearances.

195 Opinion of M. Maupertuis.

196 Mr Dunn's hypotheſis.

Laſtly, Mr Dunn (Phil. Tranſ. Vol. LII.) in a diſſertation concerning the apparent increaſe of magnitude in the heavenly bodies when they approach the horizon, conjectures that the interpoſition of ſome groſs atmoſphere may ſolve the phenomena both of nebulous and new ſtars. "The phenomena of nebulous and new ſtars (ſays he) have engaged the attention of curious aſtronomers; but none that I know of have given any reaſon for the appearance of nebulous ſtars. Poſſibly what has been before advanced may alſo be applicable for inveſtigating reaſons for thoſe ſtrange appearances in the remote parts of the univerſe. From many inſtances which might be produced concerning the nature and properties of lights and illuminations on the earth's ſurface, concerning the nature and properties of the earth's atmoſphere, and concerning the atmoſpheres and illuminations of comets, we may ſafely conclude, that the atmoſpheres of comets and of our earth are more groſs in their nature than the etherial medium which is generally diffuſed through the ſolar ſyſtem. Poſſibly a more aqueous vapour in the one than the other makes the difference. Now, as the atmoſpheres of comets and of planets in our ſolar ſyſtem are more groſs than the ether which is generally diffuſed through our ſolar ſyſtem, why may not the etherial medium diffuſed throughout thoſe other ſolar ſyſtems (whoſe centres are their reſpective fixed ſtars) be more groſs than the etherial medium diffuſed throughout our ſolar ſyſtem? This indeed is an hypotheſis, but ſuch an one as agrees exactly with nature. For theſe nebulous ſtars appear ſo much like comets, both to the naked eye and through teleſcopes, that the one cannot always, by any difference of their extraneous light, be known from the other. Such orbs of groſs ether reflecting

194 Conjectures concerning new ſtars, &c.

Concluſions from the foregoing Appearances.

flecting light more copiouſly, or like the atmoſpheres of comets, may help us to judge of the magnitudes of the orbs illuminated by thoſe remote ſuns, when all other means ſeem to fail. The appearance of new ſtars, and diſappearance of others, poſſibly may be occaſioned by the interpoſition of ſuch an etherial medium, within their reſpective orbs, as either admits light to paſs freely, or wholly abſorbs it at certain times, whilſt light is conſtantly purſuing its journey through the vaſt regions of ſpace."

In the Philoſophical Tranſactions for 1783, however, Mr Michell, in propoſing a method to determine the diſtance, magnitude, &c. of the fixed ſtars by the diminution of the velocity of their light, ſhould any ſuch thing be diſcovered, makes ſuch ſuppoſitions as ſeem totally inconſiſtent with what has been juſt now advanced. "The very great number of ſtars (ſays he) that have been diſcovered to be double, treble, &c. particularly by Mr Herſchel, if we apply the doctrine of chances, as I have heretofore done in my Inquiry into the probable parallax, &c. of the fixed ſtars, publiſhed in the Philoſophical Tranſactions for the year 1767, cannot leave a doubt with any one who is properly acquainted with the force of thoſe arguments, that by far the greateſt part, if not all of them, are ſyſtems of ſtars ſo near each other, as probably to be liable to be affected ſenſibly by their mutual gravitation; and it is therefore not unlikely, that the periods of the revolutions of ſome of theſe about their principals (the ſmaller ones being, upon this hypotheſis, to be conſidered as ſatellites to the others) may ſome time or other be diſcovered." Having then ſhown in what manner the magnitude of a fixed ſtar, if its denſity were known, would affect the velocity of its light, he concludes at laſt, that "if the ſemidiameter of a ſphere of the ſame denſity with the ſun were to exceed his in the proportion of 500 to 1, a body falling from an infinite height towards it (or moving in a parabolic curve at its ſurface) would have acquired a greater velocity than that of light; and conſequently, ſuppoſing light to be attracted by the ſame force in proportion to its *vis inertiæ* with other bodies, all light emitted from ſuch a body would be made to return towards it by its own proper gravity. But if the ſemidiameter of a ſphere, of the ſame denſity with the ſun, was of any other ſize leſs than 497 times that of the ſun, though the velocity of light emitted by ſuch a body would never be wholly deſtroyed, yet it would always ſuffer ſome diminution, more or leſs according to the magnitude of the ſphere. The ſame effects would likewiſe take place if the ſemidiameters were different from thoſe already mentioned, provided the denſity was greater or leſs in the duplicate ratio of thoſe ſemidiameters inverſely."

197 Mr Michell's conjectures concerning the nature of the fixed ſtars.

198 In what caſes light may be ſuppoſed to return to the body that emits it.

After proceeding in his calculations, in order to find the diameter and diſtance of any ſtar, he proceeds thus: "According to Mr Bouguer, the brightneſs of the ſun exceeds that of a wax candle in no leſs a proportion than that of 8000 to 1. If therefore the brightneſs of any of the fixed ſtars ſhould not exceed that of our common candles, which, as being ſomething leſs luminous than wax, we will ſuppoſe in round numbers to be only one ten thouſandth part as bright as the ſun, ſuch a ſtar would not be viſible at more than one hundredth part of the diſtance at which it would be ſeen if it were as bright as the ſun. Now, becauſe the ſun would ſtill (I apprehend, appear as bright and luminous as the ſtar Sirius, if removed to 400,000 times his preſent diſtance, ſuch a body, if no brighter than our common candles, would only appear equally luminous with that ſtar at 4000 times the diſtance of the ſun; and we might then be able, with the beſt teleſcopes, to diſtinguiſh ſome ſenſible apparent diameter of it: but the apparent diameters of the ſtars of leſſer magnitudes would ſtill be too ſmall to be diſtinguiſhable even with our beſt teleſcopes, unleſs they were yet a good deal leſs luminous; which may poſſibly, however, be the caſe with ſome of them: for though we have indeed very ſlight grounds to go upon with regard to the ſpecific brightneſs of the fixed ſtars, compared with that of the ſun at preſent, and can therefore form only very uncertain and random conjectures concerning it; yet from the infinite variety which we find in the works of the creation, it is not unreaſonable to ſuſpect, that very poſſibly ſome of the fixed ſtars may have ſo little natural brightneſs in proportion to their magnitude, as to admit of their diameters having ſome ſenſible apparent ſize when they ſhall come to be more carefully examined, and with larger and better teleſcopes than have been hitherto in common uſe.

199 Comparative brightneſs of the ſun and fixed ſtars.

200 Luminous appearance of the ſun ſuppoſed to proceed from an atmoſphere

"With regard to the ſun, we know that his whole ſurface is extremely luminous, a very ſmall and temporary interruption ſometimes, from a few ſpots, excepted. This univerſal and exceſſive brightneſs of the whole ſurface is probably owing to an atmoſphere, which being luminous throughout, and in ſome meaſure alſo tranſparent, the light proceeding from a conſiderable depth of it all arrives at the eye, in the ſame manner as the light of a great number of candles would do if they were placed one behind another, and their flames were ſufficiently tranſparent to permit the light of the more diſtant ones to paſs through thoſe that were nearer without interruption.

"How far the ſame conſtitution may take place in the fixed ſtars we do not know: probably, however, it may ſtill do ſo in many; but there are ſome appearances, with regard to a few of them, which ſeem to make it probable that it does not do ſo univerſally. Now, if I am right in ſuppoſing the light of the ſun to proceed from a luminous atmoſphere which muſt neceſſarily diffuſe itſelf equally over the whole ſurface, and I think there can be very little doubt that this is really the caſe, this conſtitution cannot well take place in thoſe ſtars which are in ſome degree periodically more and leſs luminous, ſuch as that in Collo Ceti, &c. It is alſo not very improbable, that there is ſome difference from that of the ſun in the conſtitution of thoſe ſtars which have ſometimes appeared and diſappeared, of which that in the conſtellation of Caſſiopeia is a notable inſtance. And if theſe conjectures are well founded, which have been formed by ſome philoſophers, concerning ſtars of this kind, that they are not wholly luminous, or at leaſt not conſtantly ſo, but that all, or by far the greateſt part of their ſurfaces, is ſubject to conſiderable changes, ſometimes becoming luminous, at others extinguiſhed; it is amongſt ſtars of this ſort that we are moſt likely to meet with inſtances of a ſenſible apparent diameter, their light being much more likely not to be ſo great in proportion as that of the ſun, which if removed to 400,000 times his preſent diſtance, would ſtill appear,

201 Of the variable ſtars.

I ap-

Conclusions from the foregoing Appearances.

I apprehend, as bright as Sirius, as I have obſerved above; whereas it is hardly to be expected, with any teleſcope whatſoever, that we ſhould ever be able to diſtinguiſh a well-defined diſk of any body of the ſame ſize with the ſun at much more than 10,000 times his preſent diſtance.

"Hence the greateſt diſtance at which it would be poſſible to diſtinguiſh any ſenſible apparent diameter of a body as denſe as the ſun, cannot well greatly exceed five hundred times ten thouſand; that is five million times the diſtance of the ſun; for if the diameter of ſuch a body was not leſs than 500 times that of the ſun, its light, as has been ſhown above, could never arrive at us."

202 Mr Herſchel's opinion concerning the conſtruction of the univerſe.

Mr Herſchel improving on Mr Michell's idea of the fixed ſtars being collected into groups, and aſſiſted by his own obſervations with the extraordinary teleſcopic powers already mentioned, has ſuggeſted a theory concerning the conſtruction of the univerſe entirely new and ſingular. It had been the opinion of former aſtronomers, that our ſun, beſides occupying the centre of the ſyſtem which properly belongs to him, occupied alſo the centre of the univerſe; but Mr Herſchel is of a very different opinion. "Hitherto (ſays he) the ſidereal heavens have, not inadequately for the purpoſe deſigned, been repreſented by the concave ſurface of a ſphere, in the centre of which the eye of the obſerver might be ſuppoſed to be placed. It is true, the various magnitudes of the fixed ſtars even then plainly ſuggeſted to us, and would have better ſuited the idea of an expanded firmament of three dimenſions; but the obſervations upon which I am now going to enter, ſtill farther illuſtrate and enforce the neceſſity of conſidering the heavens in this point of view. In future therefore we ſhall look upon thoſe regions into which we may now penetrate by means of ſuch large teleſcopes *, as a naturaliſt regards a rich extent of ground or chain of mountains, containing ſtrata variouſly inclined and directed, as well as conſiſting of very different materials. A ſurface of a globe or map therefore will but ill delineate the interior parts of the heavens."

203 His obſervations on the Via Lactea.

With the powerful teleſcope mentioned in the note, Mr Herſchel firſt began to ſurvey the Via Lactea, and found that it completely reſolved the whitiſh appearance into ſtars, which the teleſcopes he formerly uſed had not light enough to do. The portion he firſt obſerved was that about the hand and club of Orion; and found therein an aſtoniſhing multitude of ſtars, whoſe number he endeavoured to eſtimate by counting many fields †, and computing from a mean of theſe how many might be contained in a given portion of the milky way. In the moſt vacant place to be met with in that neighbourhood he found 63 ſtars; other ſix fields contained 110, 60, 70, 90, 70, and 74 ſtars; a mean of all which gave 79 for the number of ſtars to each field: and thus he found, that by allowing 15 minutes for the diameter of his field of view, a belt of 15 degrees long and two broad, which he had often ſeen paſs before his teleſcope in an hour's time, could not contain leſs than 50,000 ſtars, large enough to be diſtinctly numbered; beſides which, he ſuſpected twice as many more, which could be ſeen only now and then by faint glimpſes for want of ſufficient light.

Conclusions from the foregoing Appearances.

The ſucceſs he had in the milky-way ſoon induced him to turn his teleſcope to the nebulous parts of the heavens, of which an accurate liſt had been publiſhed in the *Connoiſſance des Temps* for 1783 and 1784. Moſt of theſe yielded to a Newtonian reflector of 20 feet focal diſtance and 12 inches aperture; which plainly diſcovered them to be compoſed of ſtars, or at leaſt to contain ſtars, and to ſhow every other indication of conſiſting of them entirely.

204 On the nebulæ.

205 They are arranged into ſtrata.

"The nebulæ (ſays he) are arranged into ſtrata, and run on to a great length; and ſome of them I have been able to purſue, and to gueſs pretty well at their form and direction. It is probable enough that they may ſurround the whole ſtarry ſphere of the heavens, not unlike the milky-way, which undoubtedly is nothing but a ſtratum of fixed ſtars: and as this latter immenſe ſtarry bed is not of equal breadth or luſtre in every part, nor runs on in one ſtraight direction, but is curved, and even divided into two ſtreams along a very conſiderable portion of it; we may likewiſe expect the greateſt variety in the ſtrata of the cluſters of ſtars and nebulæ. One of theſe nebulous beds is ſo rich, that in paſſing through a ſection of it in the time of only 36 minutes, I have detected no leſs than 31 nebulæ, all diſtinctly viſible upon a fine blue ſky.

206 Variety of ſhapes aſſumed by them.

Their ſituation and ſhape, as well as condition, ſeem to denote the greateſt variety imaginable. In another ſtratum, or perhaps a different branch of the former, I have often ſeen double and treble nebulæ variouſly arranged; large ones with ſmall, ſeemingly attendants; narrow, but much extended lucid nebulæ or bright daſhes; ſome of the ſhape of a fan, reſembling an electric bruſh iſſuing from a lucid point; others of the cometic ſhape, with a ſeeming nucleus in the centre, or like cloudy ſtars ſurrounded with a nebulous atmoſphere: a different ſort again contain a nebuloſity of the milky kind, like that wonderful inexplicable phenomenon about θ Orionis; while others ſhine with a fainter mottled kind of light, which denotes their being reſolvable into ſtars.

207 Why the milky-way appears to ſurround the heavens

"It is very probable that the great ſtratum called the *milky-way*, is that in which the ſun is placed, though perhaps not in the very centre of its thickneſs. We gather this from the appearance of the galaxy, which ſeems to encompaſs the whole heavens, as it certainly muſt do if the ſun is within the ſame. For ſuppoſe a number of ſtars arranged between two parallel planes, indefinitely extended every way, but at a given conſiderable diſtance from one another, and calling this a ſidereal ſtratum, an eye placed ſomewhere within it will ſee all the ſtars in the direction of the planes of the ſtratum projected into a great circle, which will appear lucid on account of the accumulation of the ſtars, while the reſt of the heavens at the ſides will only ſeem to be ſcattered over with conſtellations, more or leſs

* Mr Herſchel's obſervations, on which this theory is founded, were made with a Newtonian reflector of 20 feet focal length, and an aperture of 18 inches.

† By this word we are to underſtand the apparent ſpace in the heavens he could ſee at once through his teleſcope.

Fig. 100.

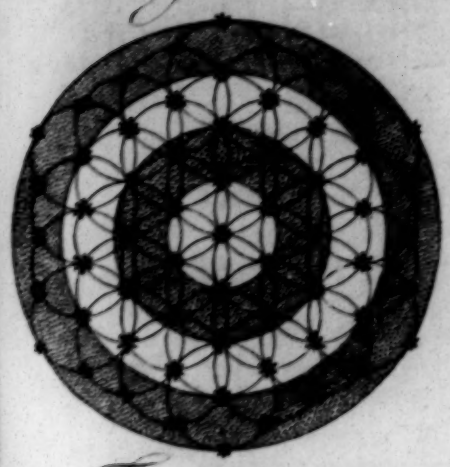


Fig. 102.

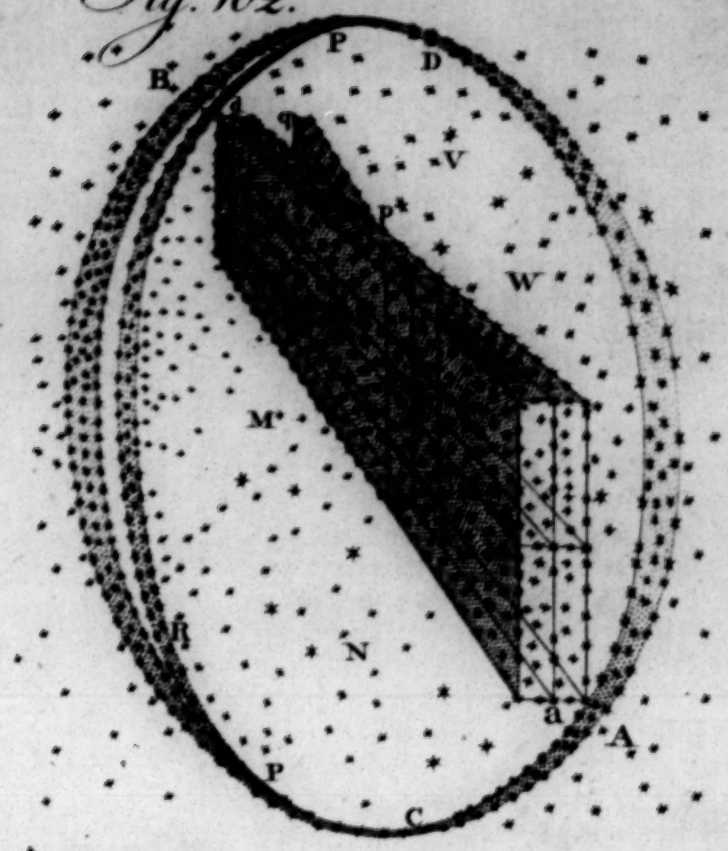


Fig. 101.

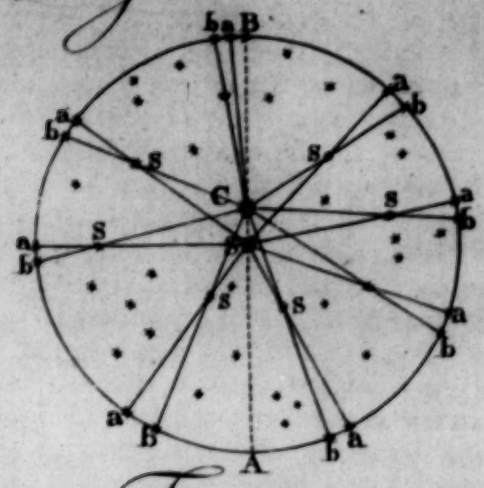


Fig. 103.

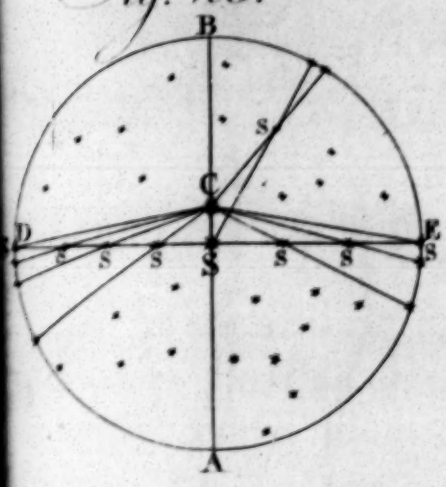


Fig. 104.

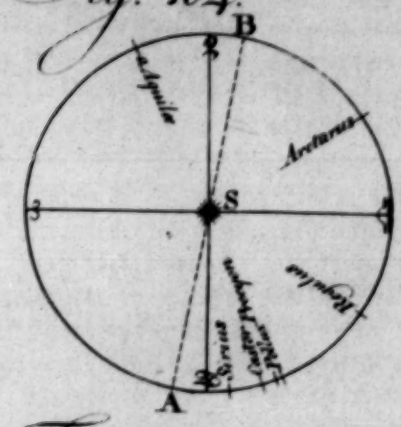


Fig. 106.

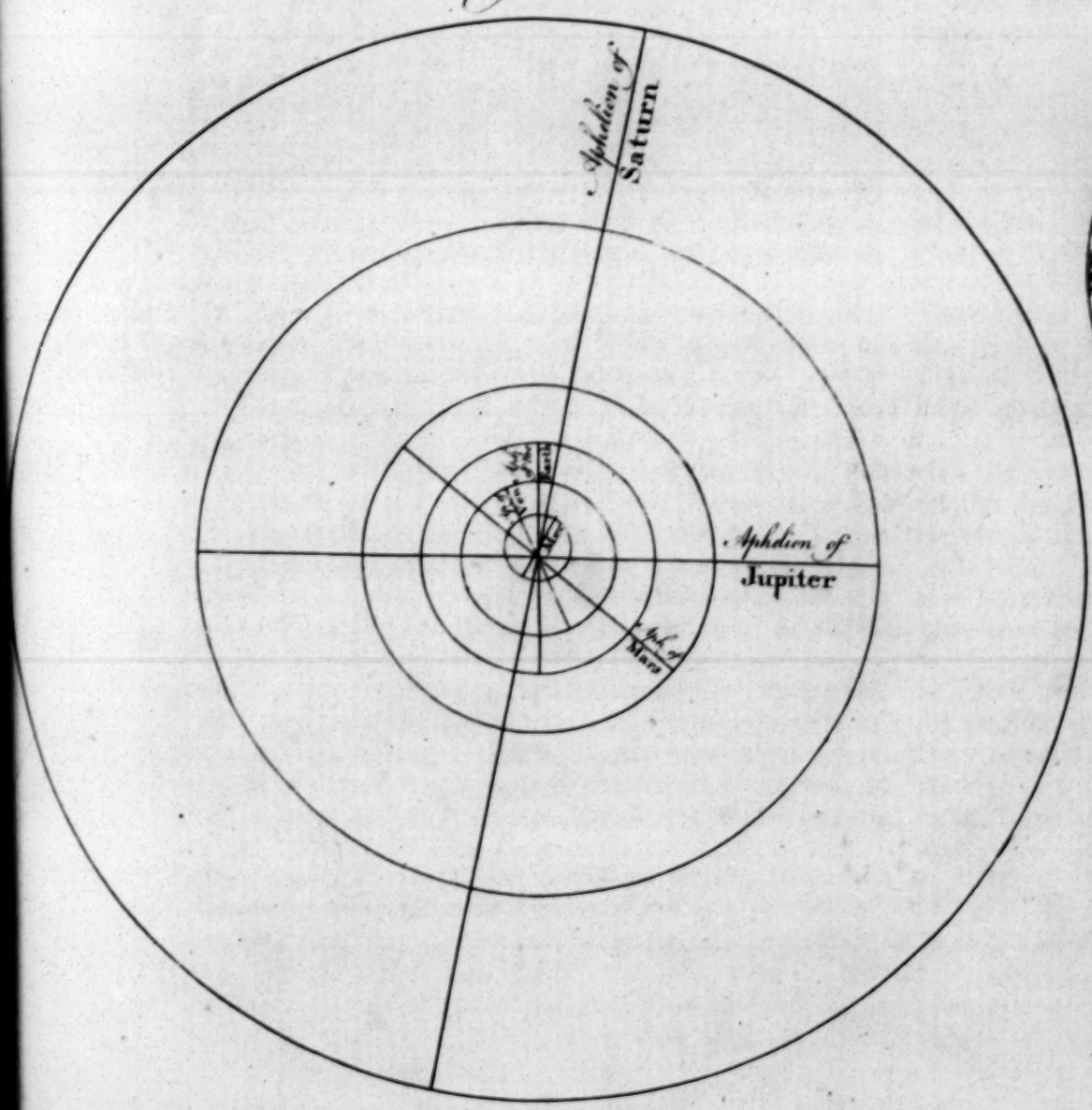


Fig. 105.

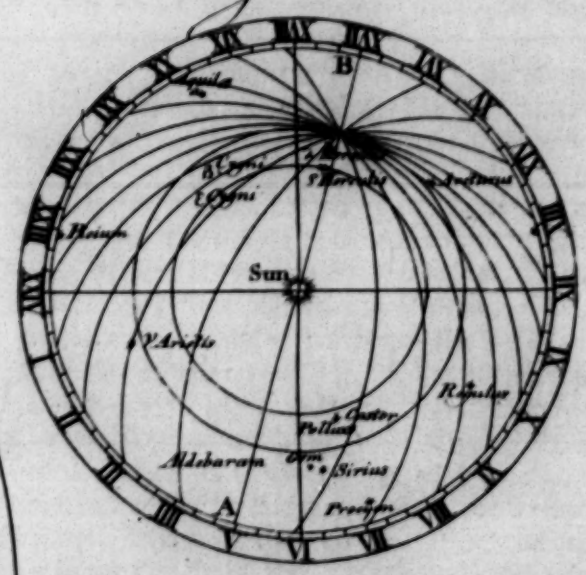
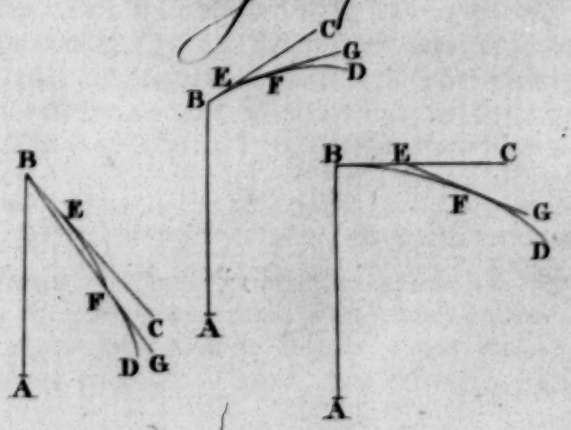


Fig. 107.



Thackara & Vallance Sculpt.

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Conclusions from the foregoing Appearances.

less crowded according to the distance of the planes or number of stars contained in the thickness or sides of the stratum,

"Thus in fig. 102. an eye at S within the stratum *ab*, will see the stars in the direction of its length *ab*, or height *ed*, with all those in the intermediate situation, projected into the lucid circle ABCD; while those in the sides *me*, *nw*, will be seen scattered over the remaining part of the heavens at MVNW.

208 Celestial appearances solved on Mr Herschel's hypothesis.

"If the eye were placed somewhere without the stratum, at no very great distance, the appearance of the stars within it would assume the form of one of the lesser circles of the sphere, which would be more or less contracted to the distance of the eye: and if this distance were exceedingly increased, the whole stratum might at last be drawn together into a lucid spot of any shape, according to the position, length, and height of the stratum.

"Let us now suppose, that a branch or smaller stratum should run out from the former in a certain direction, and let it also be contained between two parallel planes extended indefinitely onwards, but so that the eye may be placed in the great stratum somewhere before the separation, and not far from the place where the strata are still united; then will this second stratum not be projected into a bright circle like the former, but will be seen as a lucid branch proceeding from the first, and returning to it again at a certain distance less than a semicircle. Thus, in the same figure, the stars in the small stratum *p g* will be projected into a bright arch at PRRP, which, after its separation from the circle CBD, unites with it again at P.

"What has been instanced in parallel planes may easily be applied to strata irregularly bounded, and running in various directions; for their projection will of consequence vary according to the quantities of the variations in the strata and the distance of the eye from the same. And thus any kind of curvatures, as well as various degrees of brightness, may be produced in the projections.

209 Of the sun's place in the universe.

"From appearances, then, as I observed before, we may infer, that the sun is most likely placed in one of the great strata of the fixed stars, and very probably not far from the place where some smaller stratum branches out from it. Such a supposition will satisfactorily, and with great simplicity, account for all the phenomena of the milky way; which according to this hypothesis, is no other than the appearance of the projection of the stars contained in this stratum and its secondary branch. As a farther inducement to look on the galaxy in this point of view, let it be considered, that we can no longer doubt of its whitish appearance arising from the mixed lustre of the numberless stars that compose it. Now, should we suppose it to be an irregular ring of stars, in the centre nearly of which we must then suppose the sun to be placed, it will appear not a little extraordinary, that the sun, being a fixed star like those which compose this imagined ring, should just be in the centre of such a multitude of celestial bodies, without any apparent reason for this singular distinction; whereas, on our supposition, every star in this stratum, not very near the termination of its length or height, will be so placed as also to have its own galaxy, with only such variations in the form and lustre of it as may arise from the particular situation of each star.

Conclusions from the foregoing Appearances.

"Various methods may be taken to come to a knowledge of the sun's place in the sidereal stratum, one of which I have already begun to put in practice. I call it *gauging the heavens*, or the *star-gauge*. It consists in repeatedly taking the number of stars in ten fields of view of my reflector very near each other; and by adding their sums, and cutting off one decimal on the right, a mean of the contents of the heavens in all the parts which are thus gauged are obtained. Thus it appears, that the number of stars increases very much as we approach the milky way; for in the parallel from 92 to 24 degrees north polar distance, and right ascension 15 h. 10′, the star-gauge runs up from 9.4 stars in the field to 18.6 in about an hour and an half; whereas in the parallel from 78 to 80 degrees north polar distance, and R. A. 11, 12, 13, and 14 hours, it very seldom rises above 4. We are, however, to remember, that, with different instruments, the account of the gauges will be very different, especially on our supposition of the sun in a stratum of stars. For let *ab*, fig. 98. be the stratum, and suppose the small circle *g h l k* to represent the space into which, by the light and power of a given telescope, we are enabled to penetrate, and let GHLK be the extent of another portion which we are enabled to visit by means of a larger aperture and power; it is evident, that the gauges with the latter instrument will differ very much in their account of stars contained at MN and at KG or LH, when with the former they will hardly be affected with the change from *m n* to *k g* or *l k*.

210 Herschel's method of gauging the heavens.

211 How to find the place of the sun in the sidereal stratum.

"The situation of the sun in the sidereal stratum will be found by considering in what manner the star-gauge agrees with the length of a ray revolving in several directions about an assumed point, and cut off by the bounds of the stratum. Thus, in fig. 99. let S be the place of an observer; S r r r, *S r r r*, lines in the plane r S r, *r S r*, drawn from S within the stratum to one of the boundaries here represented by the plane AB. Then, since neither the situation of S nor the form of the limiting surface AB is known, we are to assume a point, and apply to it lines proportional to the several gauges that have been obtained, and at such angles from each other as they may point out; then will the termination of these lines delineate the boundary of the stratum, and consequently manifest the situation of the sun within the same.

112 Observations on nebulæ.

"In my late observations on nebulæ, I soon found, that I generally detected them in certain directions rather than in others: that the spaces preceding them were generally quite deprived of their stars, so as often to afford many fields without a single star in it: that the nebulæ generally appeared some time after among stars of a certain considerable size, and but seldom among very small stars: that when I came to one nebula, I generally found several more in the neighbourhood: that afterwards a considerable time passed before I came to another parcel. These events being often repeated in different altitudes of my instrument, and some of them at considerable distances from each other, it occurred to me that the intermediate spaces between the sweeps might also contain nebulæ; and finding this to hold good more than once, I ventured to give

Conclusions from the foregoing Appearances.

notice to my assistant at the clock, that 'I found myself on nebulous ground.' But how far these circumstances of vacant places preceding and following the nebulous strata, and their being as it were contained in a bed of stars sparingly scattered between them, may hold good in more distant portions of the heavens, and which I have not yet been able to visit in any regular manner, I ought by no means to hazard a conjecture.

213 Direction of some of the principal strata of stars.

I may venture, however, to add a few particulars about the direction of some of the capital strata, or their branches. The well-known nebula of Cancer, visible to the naked eye, is probably one belonging to a certain stratum, in which I suppose it to be so placed as to lie nearest to us. This stratum I shall call that of Cancer. It runs from ϑ Cancri towards the south, over the 67th nebula of the *Connoissance des Temps*, which is a very beautiful and pretty much compressed cluster of stars, easily to be seen by any good telescope; and in which I have observed above 200 stars at once in the field of view of my great reflector with a power of 157. This cluster appearing so plainly with any good common telescope, and being so near to the one which may be seen with the naked eye, denotes it to be probably the next in distance to that within the quartile formed by γ, δ, ε, ϑ. From the 67th nebula, the stratum of Cancer proceeds towards the head of Hydra; but I have not yet had time to trace it farther than the equator.

"Another stratum, which perhaps approaches nearer to the solar system than any of the rest, and whose situation is nearly at rectangles with the great sidereal stratum in which the sun is placed, is that of Coma Berenices, as I shall call it. I suppose the Coma itself to be one of the clusters in it, and that on account of its nearness it appears to be so scattered. It has many capital nebulæ very near it; and in all probability this stratum runs out a very considerable way. It may perhaps even make the circuit of the heavens, though very likely not in one of the great circles of the sphere; for unless it should chance to intersect the great sidereal stratum of the milky way before mentioned in the very place in which the sun is stationed, such an appearance would hardly be produced. However, if the stratum of Coma Berenices should extend so far as I apprehend it may, the direction of it towards the north lies probably, with some windings, through the Great Bear onwards to Cassiopeia, thence through the Girdle of Andromeda and the Northern Fish, proceeding towards Cetus; while towards the south it passes through the Virgin, probably on to the tail of Hydra and Centaurus."

* *Philos. Trans.* vol. 75.

214 Of the interior construction of the heavens.

By a continued series of observations, Mr Herschel became confirmed in his notions; and in a succeeding paper has given a sketch of his opinions concerning the interior construction of the heavens.—"That the milky way (says he) is a most extensive stratum of stars of various sizes, admits no longer of the least doubt; and that our sun is one of the heavenly bodies belonging to it, is as evident. I have now viewed and gauged this shining zone in almost every direction, and find it composed of shining stars, whose number, by the account of those gauges, constantly increases and decreases in proportion to its apparent brightness to the naked eye. But in order to develope the ideas of the universe that have been suggested by my late observations, it will be best to take the subject from a point of view at a considerable distance both of space and time.

Conclusions from the foregoing Appearances.

"Let us then suppose numberless stars of various sizes scattered over an indefinite portion of space, in such a manner as to be almost equally distributed thro' the whole. The laws of attraction which no doubt extend to the remotest regions of the fixed stars, will operate in such a manner as most probably to produce the following remarkable effects.

215 Consequences of the laws of attraction acting among the stars.

"I. It will frequently happen, that a star, being considerably larger than its neighbouring ones, will attract them more than they will be attracted by others that are immediately around them; by which means they will be in time, as it were, condensed about a centre; or, in other words, form themselves into a cluster of stars of almost a globular figure, more or less regularly so according to the size and original distance of the surrounding stars. The perturbations of these mutual attractions must undoubtedly be very intricate, as we may easily comprehend by considering what Sir Isaac Newton has said, *Princip.* lib. i. prob. 38, *et seq.*: but in order to apply this great author's reasoning of bodies moving in ellipsis to such as are here for a while supposed to have no other motion than what their mutual gravity has imparted to them, we must suppose the conjugate axes of these ellipses indefinitely diminished, whereby the ellipses will become straight lines.

216 Nebulæ how formed.

"II. The next case, which will happen almost as frequently as the former, is where a few stars, though not superior in size to the rest, may chance to be rather nearer each other than the surrounding ones; for here also will be formed a prevailing attraction in the combined centre of gravity of them all, which will occasion the neighbouring stars to draw together; not, indeed, so as to form a regular globular figure, but, however, in such a manner as to be condensed towards the common centre of gravity of the whole irregular cluster. And this construction admits of the utmost variety of shapes, according to the number and situation of the stars which first gave rise to the condensation of the rest.

"III. From the composition and repeated conjunction of both the foregoing forms, a third may be derived, when many large stars, or combined small ones, are situated in long extended regular or crooked rows, hooks, or branches; for they will also draw the surrounding ones so as to produce figures of condensed stars coarsely similar to the former, which gave rise to these condensations.

"IV. We may likewise admit of still more extensive combinations; when at the same time that a cluster of stars is forming in one part of space, there may be another collecting in a different, but perhaps not far distant quarter, which may occasion a mutual approach towards their common centre of gravity.

217 Vacancies how they are occasioned in the heavens.

"V. In the last place, as a natural consequence of the former cases, there will be great cavities or vacancies formed by the retreat of the stars towards the various centres which attract them; so that, upon the whole, there is evidently a field of the greatest variety for the mutual and combined attractions of the heavenly bodies to exert themselves in.

"From this theoretical view of the heavens, which has

Conclusions from the foregoing Appearances.

has been taken from a point not less distant in time than in space, we will now retreat to our own retired station, in one of the planets attending a star in its great combination with numberless others: and in order to investigate what will be the appearances from this contracted situation, let us begin with the naked eye. The stars of the first magnitude, being in all probability the nearest, will furnish us with a step to begin our scale. Setting off, therefore, with the distance of Sirius or Arcturus, for instance, as unity, we will at present suppose, that those of the second magnitude are at double, those of the third at treble, the distance, &c. Taking it for granted, then, that a star of the seventh magnitude (the smallest supposed visible with the naked eye) is about seven times as far as one of the first, it follows, that an observer who is inclosed in a globular cluster of stars, and not far from the centre, will never be able with the naked eye to see to the end of it; for since, according to the above estimations, he can only extend his view to about seven times the distance of Sirius, it cannot be expected that his eyes should reach the borders of a cluster which has perhaps not less than 50 stars in depth every where around him. The whole universe to him, therefore, will be comprised in a set of constellations richly ornamented with scattered stars of all sizes. Or if the united brightness of a neighbouring cluster of stars should, in a remarkable clear night, reach his sight, it will put on the appearance of a small, faint, whitish, nebulous cloud, not to be perceived without the greatest attention. Let us suppose him placed in a much extended stratum, or branching cluster of millions of stars, such as may fall under the third form of nebulæ already considered. Here also the heavens will not only be richly scattered over with brilliant constellations, but a shining zone or milky way will be perceived to surround the whole sphere of the heavens, owing to the combined light of those stars which are too small, that is, too remote to be seen. Our observer's sight will be so confined, that he will imagine this single collection of stars, though he does not even perceive the thousandth part of them, to be the whole contents of the heavens. Allowing him now the use of a common telescope, he begins to suspect that all the milkiness of the bright path which surrounds the sphere may be owing to stars. He perceives a few clusters of them in various parts of the heavens, and finds also that there are a kind of nebulous patches: but still his views are not extended to reach so far as to the end of the stratum in which he is situated; so that he looks upon these patches as belonging to that system which to him seems to comprehend every celestial object. He now increases his power of vision; and, applying himself to a close observation, finds that the milky way is indeed no other than a collection of very small stars. He perceives, that those objects which had been called *nebulæ*, are evidently nothing but clusters of stars. Their number increases upon him; and when he resolves one nebula into stars, he discovers ten new ones which he cannot resolve. He then forms the idea of immense strata of fixed stars, of clusters of stars and of nebulæ; till, going on with such interesting observations, he now perceives, that all these appearances must naturally arise from the confined situation in

218 How the stars must appear to us according to this hypothesis.

which we are placed. *Confined* it may justly be called, though in no less a space than what appeared before to be the whole region of the fixed stars, but which now has assumed the shape of a crookedly branching nebula; not indeed one of the least, but perhaps very far from being the most considerable, of those numberless clusters that enter into the construction of the heavens."

Conclusions from the foregoing Appearances.

219 Arguments in favour of the foregoing theory from observations on nebulæ.

Our author now proceeds to show that this theoretical view of the heavens is perfectly consistent with facts, and seems to be confirmed by a series of observations. Many hundreds of nebulæ of the first and second forms are to be seen in the heavens; and their places, he says, will hereafter be pointed out; many of the third form described, and instances of the fourth related; a few of the cavities mentioned in the fifth particularised, though many more have been already observed: so that, "upon the whole (says he), I believe it will be found, that the forgoing theoretical view, with all its consequential appearances, as seen by an eye inclosed in one of the nebulæ, is no other than a drawing from nature, wherein the features of the original have been closely copied: and I hope the resemblance will not be called a bad one, when it shall be considered how very limited must be the pencil of an inhabitant of so small and retired a portion of an indefinite system in attempting the picture of so unbounded an extent."

220 Method of measuring the dimensions of the heavens.

Mr Herschel next present us with a long table of star-gauges, or accounts of the number of stars at once in the field of his telescope, which go as high as 588; after which he proposes the following

PROBLEM.

"The stars being supposed nearly equally scattered, and their number, in a field of view of a known angular diameter, being given, to determine the length of the visual ray.

"Here, the arrangement of the stars not being fixed upon, we must endeavour to find which way they may be placed so as to fill a given space most equally. Suppose a rectangular cone cut into frustula by many equidistant planes perpendicular to the axis; then, if one star be placed at the vertex and another in the axis at the first intersection, six stars may be set around it so as to be equally distant from one another and from the central star. These positions being carried on in the same manner, we shall have every star within the cone surrounded by eight others at an equal distance from that star taken at a centre. Fig. 100 contains four sections of such a cone distinguished by alternate shades; which will be sufficient to explain what sort of arrangements I would point out.

"The series of the number of stars contained in the several sections will be 1, 7, 19, 37, 61, 91, &c. which, continued to n terms, the sum of it, by the differential method, will be $na+n.\frac{n-1}{2}d'+n.\frac{n-1}{2}.\frac{n-2}{3}d'''$, &c. where a is the first term, d', d''', d'''', &c. the first, second, and third differences. Then, since $a=1$, $d'=6$, $d'''=6$, $d''''=0$, the sum of the series will be n^3. Let S be the given number of stars; 1 the diameter of the base of the field of view; and B the diameter of the great rectangular cone; and by trigonometry we shall

Conclusions from the foregoing Appearances.

have $B = \frac{\text{Radius}}{\text{Tang. } \frac{1}{2} \text{ field}}$. Now, since the field of view of a telescope is a cone, we shall have its solidity to that of the great cone of the stars formed by the above construction, as the square of the diameter of the base of the field of view to the square of the diameter of the great cone, the height of both being the same; and the stars in each cone being in the ratio of the solidity, as being equally scattered, we have $n = \sqrt[3]{B \cdot S}$; and the length of the visual ray $= n - 1$, which was to be determined." Another solution of this problem, on the supposition of another arrangement of stars, is given; but Mr Herschel prefers the former.

221 Proofs of our sidereal system being a nebula.

From the data now laid down, Mr Herschel next endeavours to prove that the earth is 'the planet of a star belonging to a compound nebula of the third form.' "I shall now (says he) proceed to show, that the stupendous sidereal system we inhabit, this extensive stratum, and its secondary branch, consisting of many millions of stars, is in all probability *a detached nebula*. In order to go upon grounds that seem to me to be capable of great certainty, they being no less than an actual survey of the boundaries of our sidereal system, which I have plainly perceived as far as I have yet gone round it, every where terminated, and in most places very narrowly too, it will be proper to show the length of my sounding line, if I may so call it, that it may appear whether it was sufficiently long for the purpose.

222 Length of the line by which Mr Herschel measures the heavens

"In the most crowded parts of the milky-way, I have had fields of view that contained no fewer than 583 stars, and these were continued for many minutes; so that in one quarter of an hour's time there passed no less than 116,000 stars through the field of view of my telescope. Now, if we compute the length of the visual ray, by putting $S = 588$, and the diameter of the field of view 15 minutes, we shall find $n = \sqrt[3]{B \cdot S} = 498$; so that it appears the length of what I have called my Sounding Line, or $n - 1$, was not probably less than 497 times the distance of Sirius from the sun.

"It may seem inaccurate that we should found an argument on the stars being equally scattered, when, in all probability, there may not be any two of them in the heavens whose mutual distance shall be equal to that of any other two given stars: but it should be considered, that when we take all the stars collectively, there will be a mean distance which may be assumed as the general one; and an argument founded on such a supposition will have in its favour the greatest probability of not being far short of truth. And here I must observe, that the difference between a crowded place and a cluster (none of the latter being put into the gauge table), may easily be perceived by the arrangement as well as the size and mutual distance of the stars: for in a cluster they are generally not only resembling each other pretty nearly in size, but a certain uniformity of distance also takes place: they are more and more accumulated towards the centre, and put on all the appearances which we should naturally expect from a number of them collected into a group at a certain distance from us. On the other hand, the rich parts of the milky-way, as well as those in the distant broad parts of the stratum, consist of a mixture of stars of all possible sizes, that are seemingly placed without any particular apparent order. Perhaps we might recollect, that a greater condensation towards the centre of our system than towards the borders of it should be taken into consideration; but with a nebula of the third form, containing such various and extensive combinations as I have found to take place in ours, this circumstance, which in one of the first form would be of considerable moment, may, I think, be safely neglected.

223 Cluster of stars defined.

Conclusions from the foregoing Appearances.

"If some other high gauge be selected from the table, such as 472 or 344, the length of the visual ray will be found 461 and 415. And although in consequence of what has been said, a certain degree of doubt may be left about the arrangement and scattering of the stars, yet when it is recollected, that in those parts of the milky-way, where these high gauges were taken, the stars were neither so small nor so crowded as they must have been, on a supposition of a much farther continuance of them, when certainly a milky or nebulous appearance must have come on, I need not fear to have over-rated the extent of my visual ray; and indeed every thing that can be said to shorten it will only contract the limits of our nebulæ, as it has in most places been of sufficient length to go far beyond the bounds of it. Thus in the sides of our stratum, opposite to our situation in it, where the gauges often run below 5, our nebulæ cannot extend to 100 times the distance of Sirius; and the same telescope which could show 588 stars in a field of view of 15 minutes, must certainly have presented me also with the stars in these situations, had they been there. If we should answer this by observing, that they might be at too great a distance to be perceived, it will be allowing that there must at least be a vacancy amounting to the length of a visual ray, not short of 400 times the distance of Sirius: and this is amply sufficient to make our nebulæ a detached one. It is true, that it would not be consistent confidently to affirm that we were on an island, unless we had found ourselves every where bounded by the ocean; and therefore I shall go no farther than the gauges will authorise: but considering the little depth of the stratum in all those places which have been actually gauged, to which must be added all the intermediate parts that have been viewed and found to be much like the rest, there is but little room to expect a connection between our nebula and any of the neighbouring ones. A telescope, with a much larger aperture than my present one, grasping together a greater quantity of light, and thereby enabling us to see farther into space, will be the surest means of completing and establishing the arguments that have been used: for if our nebula is not absolutely a detached one, I am firmly persuaded that an instrument may be made large enough to discover the places where the stars continue onwards. A very bright milky nebulosity must there undoubtedly come on, since the stars in a field of view will increase in the ratio of n^3 greater than that of the cube of the visual ray. Thus, if 588 stars in a given field of view are to be seen by a ray of 497 times the distance of Sirius, when this is lengthened to 1000, which is but little more than double the former, the number of stars in the same field of view will

224 Extent of our nebula.

Conclusions from the foregoing Appearances.

will be no less than 4774: for when the visual ray r is given, the number of stars S will be $=\frac{n^3}{B^3}$; where $n=r+1$; and a telescope with a threefold power of extending into space, or with a ray of 1500, which I think may easily be constructed, will give us 16,096 stars. Nor would these be so close, but that a good power applied to such an instrument might easily distinguish them; for they need not, if arranged in regular squares, approach nearer to each other than 6″.27: but the milky nebulosity I have mentioned, would be produced by the numberless stars beyond them, which, in one respect, the visual ray might also be said to reach. To make this appear, we must return to the naked eye; which, as we have before estimated, can only see the stars of the seventh magnitude so as to distinguish them: but it is nevertheless very evident, that the united lustre of millions of stars, such as I suppose the nebula in Andromeda to be, will reach our sight in the shape of a very small faint nebulosity; since the nebula of which I speak may easily be seen in a fine evening. In the same manner, my present telescope, as I have argued, has not only a visual ray that will reach the stars at 497 times the distance of Sirius, so as to distinguish them, and probably much farther, but also a power of showing the united lustre of the accumulated stars that compose a milky nebulosity at a distance far exceeding the former limits; so that from these considerations it appears again highly probable, that my present telescope not showing such a nebulosity in the milky-way, goes already far beyond its extent: and consequently much more would an instrument, such as I have mentioned, remove all doubt on the subject, both by showing the stars in the continuation of the stratum, and by exposing a very strong milky nebulosity beyond them, that could no longer be mistaken for the dark ground of the heavens.

225 Analogical arguments in favour of his doctrine.

"To these arguments, which rest on the firm basis of a series of observation, we may add the following considerations drawn from analogy. Among the great number of nebulæ which I have now already seen, amounting to more than 900, there are many which in all probability are equally extensive with that which we inhabit; and yet they are all separated from each other by very considerable intervals. Some, indeed, there are that seem to be double and treble; and though with most of these it may be that they are at a very great distance from each other, yet we allow that some such conjunctions really are to be found; nor is this what we mean to exclude. But then these compound, or double nebulæ, which are those of the third and fourth forms, still make a detached link in the great chain. It is also to be supposed, that there may be some thinly scattered solitary stars between the large interstices of nebulæ; which being situated so as to be nearly equally attracted by the several clusters when they were forming, remain unassociated: and though we cannot expect to see those stars on account of their vast distance, yet we may well presume that their number cannot be very considerable in comparison to those that are already drawn into systems: which conjecture is also abundantly confirmed in situations where the nebulæ are near enough to have their stars visible; for they are all insulated, and generally to be seen upon a very clear and pure ground, without any star near them that might be thought to belong to them. And though I have often seen them in beds of stars, yet from the size of these latter we may be certain, that they were much nearer to us than those nebulæ, and belonged undoubtedly to our own system.

Conclusions from the foregoing Appearances.

Having thus determined that the visible system of nature, by us called the *universe*, consisting of all the celestial bodies and many more than can be seen by the naked eye, is only a group of stars or suns with their planets, constituting one of those patches called a *nebula*, and perhaps not one ten thousandth part of what is really the universe, Mr Herschel goes on to delineate the figure of this vast nebula, which he is of opinion may now be done; and for this purpose he gives a table, calculating the distance of the stars which form its extreme boundaries, or the length of the visual ray in different parts, by the number of stars contained in the field of his telescope at different times, according to the principles already laid down. He does not, however, as yet attempt the whole nebula, but of a particular section, represented fig. 160. "I have taken one (says he) which passes through the poles of our system, and is at rectangles to the conjunction of the branches, which I have called its *length*. The name of *poles* seemed to me not improperly applied to those points which are 90 degrees distant from a circle passing along the milky way; and the north pole is here supposed to be situated in right ascension 186°, and polar distance (that is from the pole commonly so called) 58°. The section is one which makes and angle of 35 degrees with our equator, crossing it in 124½ and 304½ degrees. A celestial globe, adjusted to the latitude of 55° north, and having σ Ceti near the meridian, will have the plane of this section pointed out by the horizon. The visual rays are to be projected on the plane of the horizon of the latitude just mentioned, which may be done accurately enough by a globe adjusted in the manner directed. The stars in the border, which are marked larger than the rest, are those pointed out by the gauges. The intermediate parts are filled up by smaller stars, arranged in straight lines between the gauged ones. From this figure, which I hope is not a very inaccurate one, we may see that our nebula, as we observed before, is of the third form; that is, a very extensive, branching, compound congeries of many millions of stars, which most probably owes its origin to many remarkably large, as well as pretty closely scattered small stars, that may have drawn together the rest. Now to have some idea of the wonderful extent of this system, I must observe, that this section of it is drawn upon a scale where the distance of Sirius is no more than the 80th part of an inch; so that probably all the stars, which in the finest nights we are able to distinguish with the naked eye, may be comprehended within a sphere drawn round the large star near the middle, representing our situation in the nebula of less than half a quarter of an inch radius."

226 How the figure of our nebula may be delineated.

Mr Herschel now proceeds to offer some further thoughts on the origin of the nebulous strata of the heavens; in doing which he gives some hints concerning the antiquity of them. "If it were possible (says he) to distinguish between the parts of an indefinitely extended whole, the nebula we inhabit might be said

to

Conclusions from the foregoing Appearances.

to be one that has fewer marks of antiquity than any of the reſt. To explain this idea perhaps more clearly, we ſhould recollect, that the condenſation of cluſters of ſtars has been aſcribed to a gradual approach; and whoever reflects on the number of ages that muſt have paſſed before ſome of the cluſters that are to be found in my intended catalogue of them could be ſo far condenſed as we find them at preſent, will not wonder if I aſcribe a certain air of youth and vigour to many very regularly ſcattered regions of our ſidereal ſtratum.

127 Of the decay and recompoſition of nebulæ.

There are, moreover, many places in it in which, if we may judge from appearances, there is the greateſt reaſon to believe that the ſtars are drawing towards ſecondary centres, and will in time ſeparate into cluſters, ſo as to occaſion many ſubdiviſions. Hence we may ſurmiſe, that when a nebulous ſtratum conſiſts chiefly of nebulæ of the firſt and ſecond forms, it probably owes its origin to what may be called the decay of a great compound nebula of the third form; and that the ſubdiviſions which happened to it in length of time, occaſioned all the ſmall nebulæ which ſprung from it to lie in a certain range, according as they were detached from the primary one. In like manner, our ſyſtem, after numbers of ages, may very poſſibly become divided ſo as to give riſe to a ſtratum of two or three hundred nebulæ; for it would not be difficult to point out ſo many beginning or gathering cluſters in it. This throws a conſiderable light upon that remarkable collection of many hundreds of nebulæ which are to be ſeen in what I have called the *nebulous ſtratum* in Coma Berenices. It appears from the extended and branching figure of our nebula, that there is room for the decompoſed ſmall nebulæ of a large reduced former great one to approach nearer to us in the ſides than in any other parts. Nay, poſſibly there might originally be another very large joining branch, which in time became ſeparated by the condenſation of the ſtars: and this may be the reaſon of the little remaining breadth of our ſyſtem in that very place; for the nebulæ of the ſtratum of the Coma are brighteſt and moſt crowded juſt oppoſite to our ſituation, or in the pole of our ſyſtem. As ſoon as this idea was ſuggeſted, I tried alſo the oppoſite pole; where accordingly I have met with a great number of nebulæ, though under a much more ſcattered form.

"Some parts of our ſyſtem indeed ſeem already to have ſuſtained greater ravages of time than others: for inſtance, in the body of the Scorpion is an opening or hole, which is probably owing to this cauſe. It is at leaſt four degrees broad; but its height I have not yet aſcertained. It is remarkable, that the 80 *Nebuleuſe ſans Etoiles* of the *Connoiſſance des Temps*, which is one of the richeſt and moſt compreſſed cluſters of ſmall ſtars I remember to have ſeen, is ſituated juſt on the weſt border of it, and would almoſt authoriſe a ſuſpicion that the ſtars of which it is compoſed were collected from that place, and had left the vacancy. What adds not a little to this ſurmiſe is, that the ſame phenomenon is once more repeated with the fourth cluſter of the *Connoiſſance des Temps*; which is alſo on the weſtern border of another vacancy, and has moreover a ſmall miniature cluſter, or eaſily reſolvable nebula, of about 2½ minutes in diameter north, following it at no very great diſtance.

"There is a remarkable purity or clearneſs in the heavens when we look out of our ſtratum at the ſides; that is, towards Leo, Virgo, and Coma Berencies on one hand, and towards Cetus on the other; whereas the ground of the heavens becomes troubled as we approach towards the length or height of it. Theſe troubled appearances are eaſily to be explained by aſcribing them to ſome of the diſtant ſtraggling ſtars that yield hardly light enough to be diſtinguiſhed. And I have indeed often experienced this to be the cauſe, by examining theſe troubled ſpots for a long while together, when at laſt I generally perceived the ſtars which occaſioned them. But when we look towards the poles of our ſyſtem, where the viſual ray does not graze along the ſide, the ſtraggling ſtars will of courſe be very few in number: and therefore the ground of the heavens will aſſume that purity which I have always obſerved to take place in thoſe regions."

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228 Univerſe compoſed of nebulæ.

Thus, then, according Mr Herſchel, the univerſe conſiſts of *nebulæ*, or innumerable collections of innumerable ſtars, each individual of which is a ſun not only equal, but much ſuperior to ours: at leaſt if the words of Mr Nicholſon have any weight; for he tells us, that "each individual ſun is deſtined to give light to *hundreds* of worlds that revolve about it, but which can no more be ſeen by us, on account of their great diſtance, than the ſolar planets can be ſeen from the fixed ſtars." "Yet (continues he), as in this unexplored, and perhaps unexplorable, abyſs of ſpace, it is no neceſſary condition that the planets ſhould be of the ſame magnitudes as thoſe belonging to our ſyſtem, it is not impoſſible but that planetary bodies may be diſcovered among the double and treble ſtars."

Nat. Phil. 165, 166. Philad. Edit.

Though in the above extracts from Mr Herſchel's papers, the words *condenſation*, *cluſters*, &c. of ſtars frequently occur, we are by no means from thence to imagine that any of the celeſtial bodies in our nebulæ are nearer to one another than we are to Sirius, whoſe diſtance is ſuppoſed not to be leſs than 400,000 times that of the ſun from us, or 38 millions of millions of miles. The whole extent of the nebula being in ſome places near 500 times as great, muſt be ſuch, that the light of a ſtar placed at its extreme boundary, ſuppoſing it to fly with the velocity of 12 millions of miles every minute, muſt have taken near 3000 years to reach us. Mr Herſchel, however, is by no means of opinion, that our nebula is the moſt conſiderable in the univerſe. "As we are uſed (ſays he to call the appearance of the heavens, where it is ſurrounded with a bright zone, the *milky-way*, it may not be amiſs to point out ſome other very remarkable nebulæ, which cannot well be leſs, but are probably much larger, than our own ſyſtem; and being alſo extended, the inhabitants of the planets that attend the ſtars which compoſe them, muſt likewiſe perceive the ſame phenomena: for which reaſon they may alſo be called *milky ways*, by way of diſtinction.

229 Of the ſize and diſtance of nebulæ.

"My opinion of their ſize is grounded on the following obſervations: There are many round nebulæ of the firſt form, of about five or ſix minutes in diameter, the ſtars of which I can ſee very diſtinctly; and on comparing them with the viſual ray calculated from ſome of my long guages, I ſuppoſe by the appearance of the ſmall ſtars in thoſe guages, that the centres of theſe round nebulæ may be 600 times the diſtance of Sirius

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Sirius from us."—He then goes on to tell us, that the ſtars in ſuch nebulæ are probably twice as much condenſed as thoſe of our ſyſtem; otherwiſe the centre of it would not be leſs than 6000 times the diſtance of Sirius from us; and that it is probably much underrated by ſuppoſing it only 600 times the diſtance of that ſtar.

"Some of theſe round nebulæ (ſays Mr Herſchel), have others near them, perfectly ſimilar in form, colour, and the diſtribution of ſtars, but of only half the diameter: and the ſtars in them ſeem to be doubly crowded, and only at about half the diſtance from each other. They are indeed ſo ſmall, as not to be viſible without the utmoſt attention. I ſuppoſe theſe miniature nebulæ to be at double the diſtance of the firſt. An inſtance equally remarkable and inſtructive is a caſe where, in the neighbourhood of two ſuch nebulæ as have been mentioned, I met with a third ſimilar, reſolvable, but much ſmaller and fainter nebula. The ſtars of it are no longer to be perceived; but a reſemblance of colour with the former two, and its diminiſhed ſize and light, may well permit us to place it at full twice the diſtance of the ſecond, or about four or five times the diſtance of the firſt. And yet the nebuloſity is not of the milky kind; nor is it ſo much as difficultly reſolvable or colourleſs. Now in a few of the extended nebulæ, the light changes gradually, ſo as from the reſolvable to approach to the milky kind; which appears to me an indication, that the milky light of nebulæ is owing to their much greater diſtance. A nebula, therefore, whoſe light is perfectly milky, cannot well be ſuppoſed to be at leſs than ſix or eight thouſand times the diſtance of Sirius; and though the numbers here aſſumed are not to be taken otherwiſe than as very coarſe eſtimates, yet an extended nebula, which in an oblique ſituation, where it is poſſibly foreſhortened by one-half, two-thirds, or three-fourths of its length, ſubtends a degree or more in diameter, cannot be otherwiſe than of a wonderful magnitude, and may well out-vie our milky-way in grandeur."

Mr Herſchel next proceeds to give an account of ſeveral remarkable nebulæ, and then concludes thus.

230 Vaſt length of time requiſite to form the nebulæ.

"Now, what great length of time muſt be required to produce theſe effects (the formation of nebulæ) may eaſily be conceived, when, in all probablility, our whole ſyſtem, of about 800 ſtars in diameter, if it were ſeen at ſuch a diſtance that one end of it might aſſume the reſolvable nebuloſity, would not, at the other end, preſent us with the irreſolvable, much leſs with the colourleſs and milky, ſort of nebuloſities." Great indeed muſt be the length of time requiſite for ſuch diſtant bodies to form combinations by the laws of attraction, ſince, according to the diſtances he has aſſumed, the light of ſome of his nebulæ muſt be thirty-ſix or forty-eight thouſand years in arriving from them to us. It would be worth while then to inquire, whether *attraction* is a virtue propagated in time or not; or whether it moves quicker or ſlower than light?

231 Why the ſtars do not fall upon one another

In the courſe of Mr Herſchel's obſervations and inquiries concerning the ſtructure of the heavens, an objection occurred, that if the different ſyſtems were formed by the mutual attractions of the ſtars, the whole would be in danger of deſtruction by the falling of them one upon another. A ſufficient anſwer to this, he thinks, is, that if we can really prove the ſyſtem of the univerſe to be what he has ſaid, there is no doubt but that the great Author of it has amply provided for the preſervation of the whole, though it ſhould not appear to us in what manner this is effected. Several circumſtances, however, he is of opinion, manifeſtly tend to a general preſervation; as, in the firſt place, the indefinite extent of the ſidereal heavens; which muſt produce a balance that will effectually ſecure all the great parts of the whole from approaching to each other. "There remains then (ſays he) only to ſee how the particular ſtars belonging to ſeparate cluſters are prevented from ruſhing on to their centres of attraction." This he ſuppoſes may be done by projectile forces; "the admiſſion of which will prove ſuch a barrier againſt the ſeeming deſtructive power of attraction, as to ſecure from it all the ſtars belonging to a cluſter, if not for ever, at leaſt for millions of ages. Beſides, we ought perhaps to look upon ſuch cluſters, and the deſtruction of a ſtar now and then in ſome thouſands of ages, as the very means by which the whole is preſerved and renewed. Theſe cluſters may be the *laboratories* of the univerſe, wherein the moſt ſalutary remedies for the decay of the whole are prepared."

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232 Of the planetary nebulæ.

In ſpeaking of the planetary nebulæ, by which name he diſtinguiſhes thoſe ſpots that are all over equally luminous, he ſays, "if we ſhould ſuppoſe them to be ſingle ſtars with large diameters, we ſhall find it difficult to account for their not being brighter, unleſs we ſhould admit that the intrinſic light of ſome ſtars may be very much inferior to that of the generality; which, however, can hardly be imagined to extend to ſuch a degree. We might ſuppoſe them to be comets about their aphelion, if the brightneſs, as well as magnitude of their diameters, did not oppoſe this idea: ſo that, after all, we can hardly find any hypotheſis ſo probable as that of their being nebulæ; but then they muſt conſiſt of ſtars that are compreſſed and accumulated in the higheſt degree. If it were not perhaps too hazardous to purſue a former ſurmiſe of a renewal in what I figuratively called the *Laboratories of the Univerſe*, the ſtars forming theſe extraordinary nebulæ, by ſome decay or waſte of nature being no longer fit for their former purpoſes, and having their projectile forces, if any ſuch they had, retarded in each others atmoſphere, may ruſh at laſt together; and, either in ſucceſſion, or by one general tremendous ſhock, unite into a new body. Perhaps the extraordinary and ſudden blaze of a new ſtar in Caſſiopeia's chair, in 1572, might poſſibly be of ſuch a nature. If a little attention to theſe bodies ſhould prove that, having no annual parallax, they belong moſt probably to the claſs of nebulæ, they may then be expected to keep their ſtation better than any one of the ſtars belonging to our ſyſtem, on account of their being probably at a very great diſtance."

233 Motion of the fixed ſtars and ſolar ſyſtem.

Having thus at length got through the conjectures and theories concerning the nature and ſituations of the heavenly bodies, we muſt now proceed to conſider thoſe projectile forces which are ſuppoſed neceſſary to the preſervation of the ſyſtem of Nature, and to prevent the ſtars from falling upon one another more frequently than they do. It was firſt ſuſpected by Dr Halley, that many of the ſtars which we call *fixed*, are really in motion, though that motion is either ſo ſlow

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in itſelf, or their diſtance is ſo great, that it can ſcarce be perceptible in half a century. It is, however, now confirmed by aſtronomical obſervations, that Arcturus, Sirius, Aldebaran, Procyon, Caſtor, Rigel, Altair, and many others, are actually in motion: which conſideration, with the length of time neceſſary to ſhow any change of place in bodies at ſuch extreme diſtance, with the lateneſs of any obſervations on this head, "would lead us (ſays Mr Herſchel) to ſuppoſe that there is not one fixed ſtar in the heavens: but "many other reaſons (adds he) will render this ſo obvious, that there can hardly remain a doubt of the general motion of all the ſtarry ſyſtems, and conſequently of the ſolar one among the reſt.

234 Attraction prevents the ſtars from remaining at abſolute reſt.

"I might begin with principles drawn from the theory of attraction, which evidently oppoſe every idea of abſolute reſt in any one of the ſtars, when once it is known that ſome of them are in motion, for the change that muſt ariſe by ſuch motion, in the value of a power which acts inverſely as the ſquares of the diſtances, muſt be felt in all the neighbouring ſtars; and if theſe be influenced by the motion of the former, they will again affect thoſe that are next to them, and ſo on, till all are in motion. Now, as we know ſeveral ſtars in divers parts of the heavens do actually change their place, it will follow, that the motion of our ſolar ſyſtem is not a mere hypotheſis. And what will give additional weight to this conſideration is, that we have the greateſt reaſon to ſuppoſe moſt of thoſe very ſtars which have been obſerved to move, to be ſuch as are neareſt to us; and therefore their influence on our ſituation would alone prove a powerful argument in favor of the proper motion of the ſun had it been originally at reſt."

After enumerating a great many changes, which, from his own obſervation, have happened among the fixed ſtars, and of which we have already given an account, "Does it not ſeem natural (ſays he), that theſe obſervations ſhould cauſe a ſtrong ſuſpicion that moſt probably every ſtar in the heaven is more or leſs in motion? And though we have no reaſon to think that the diſappearance of ſome ſtars, or new appearance of others, nor indeed that the frequent changes in the magnitude of ſo many of them, are owing to their change of diſtance from us by proper motions, which could not occaſion theſe phenomena without being inconceivably quick; yet we may well ſuppoſe, that motion is ſome way or other concerned in producing theſe effects. A ſlow motion, for inſtance, in an orbit round ſome large opaque body, where the ſtar which is loſt or diminiſhed in magnitude might undergo occaſional occultations, would account for ſome of thoſe changes; while others might perhaps be owing to the periodical return of ſome large ſpots on that ſide of the ſurface which is alternately turned towards us by the rotatory motion of the ſtar. The idea, alſo, of a body much flattened by a quick rotation, and having a motion ſimilar to the moon's orbit by a change of the place of its nodes, whereby more of the luminous ſurface would one time be expoſed to us than another, tends to the ſame end: for we cannot help thinking with M. de la Lande (Mem. 1776), that the ſame force which gave ſuch rotations, would probably alſo produce motions of a different kind by a tranſlation of the centre. Now, if the proper motion of the ſtars in general be once admitted, who can refuſe to allow that our ſun, with all its planets and comets, that is, the ſolar ſyſtem, is no leſs liable to ſuch a general agitation as we find to obtain among the reſt of the celeſtial bodies?

235 Conjectures concerning the appearance of new ſtars

"Admitting this for granted, the greateſt difficulty will be, how to diſcern the proper motion of the ſun among ſo many other and variouſly compounded motions of the ſtars. This is an arduous taſk indeed; but I ſhall point out a method of detecting the direction and quantity of the ſuppoſed proper motion of the ſun by a few geometrical deductions; and at the ſame time ſhow, by an application of them to ſome known facts, that we have already ſome reaſon to gueſs which way the ſolar ſyſtem is probably tending its courſe.

Conclusions from the foregoing Appearances.

236 How to diſcover the proper motion of the ſun.

"Suppoſe the ſun to be at S. fig. 101, the fixed ſtars to be diſperſed in all poſſible directions and diſtances around, at *s*, *s*, *s*, *s*, &c. Now, ſetting aſide the proper motion of the ſtars, let us firſt conſider what will be the conſequence of a proper motion in the ſun, and let it move in a direction from A towards B. Suppoſe it now arrived at C: here, by a mere inſpection of the figure, it will be evident, that the ſtars *s*, *s*, *s*, which were before ſeen at *aaa*, will now, by the motion of the ſun from S to C, appear to have gone in a contrary direction, and be ſeen at *bbb*; that is to ſay, every ſtar will appear more or leſs to have receded from the point B, in the order of the letters *ab*, *ab*, *ab*. The converſe of this propoſition is equally true; for if the ſtars ſhould all appear to have had a retrograde motion with reſpect to the point B, it is plain, on a ſuppoſition of their being at reſt, the ſun muſt have a direct motion towards the point B, to occaſion all theſe appearances. From a due conſideration of what has been ſaid, we may draw the following inferences:

"1. The greateſt, or total ſyſtematical parallax of the fixed ſtars (fig. 103), will fall upon thoſe that are in the line D E, at rectangles to the direction A B of the ſun's motion.

"2. The partial ſyſtematical parallax of every other ſtar *s*, *s*, *s*, not in the line D E, will be to the total parallax as the ſine of the angle BS*a*, being the ſtar's diſtance from that point towards which the ſun moves, to radius.

"3. The parallax of ſtars at different diſtances will be inverſely as theſe diſtances; that is, one half at double the diſtance, one third at three times, and ſoon; for the ſubtenſe SC remaining the ſame, and the parallactic angle being very ſmall, we may admit the angle S*s*C to be inverſely as the ſide S*s*, which is the ſtar's diſtance.

"4. Every ſtar at reſt, to a ſyſtem in motion, will appear to move in a direction contrary to that which the ſyſtem has. Hence it follows, that if the ſolar ſyſtem be carried towards any ſtar ſituated in the ecliptic, every ſtar, whoſe angular diſtance in *antecedentia* (reckoned upon the ecliptic from the ſtar towards which the ſyſtem moves) is leſs than 180 degrees, will decreaſe in longitude; and that, on the contrary, every ſtar, whoſe diſtance from the ſame ſtar (reckoned upon the ecliptic, but *in conſequentia*) is leſs than 180 degrees, will increaſe in longitude in both caſes, without alteration of latitude.

The immenſe regions of the fixed ſtars may be conſidered as an infinitely expanded globe, having the ſo-

ASTRONOMY

Plate LXXI

Fig. 108

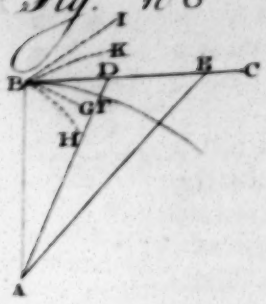


Fig 109

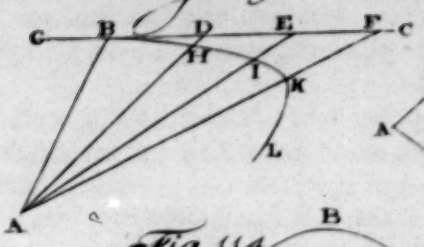


Fig. 110

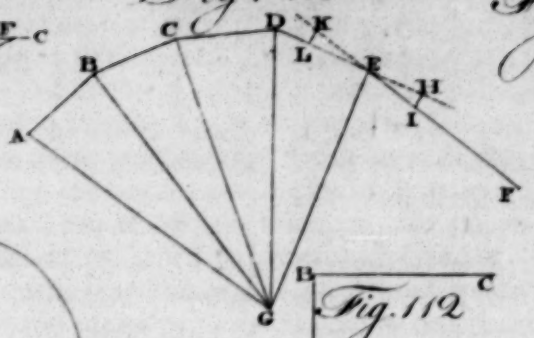


Fig. 111

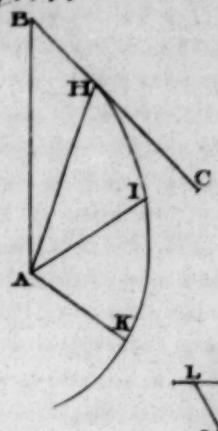


Fig. 115

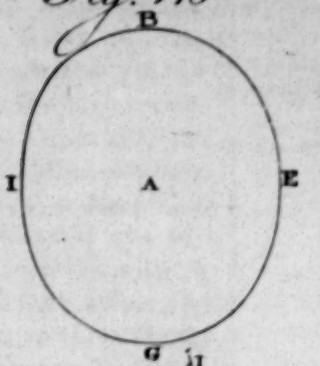


Fig. 114

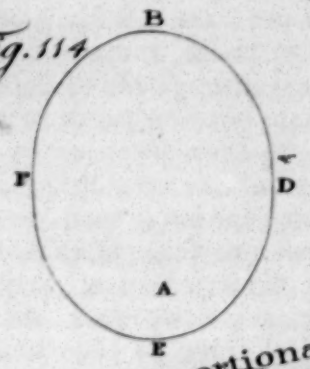


Fig. 112

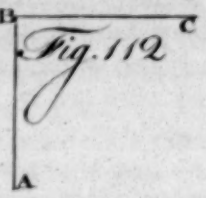


Fig. 113

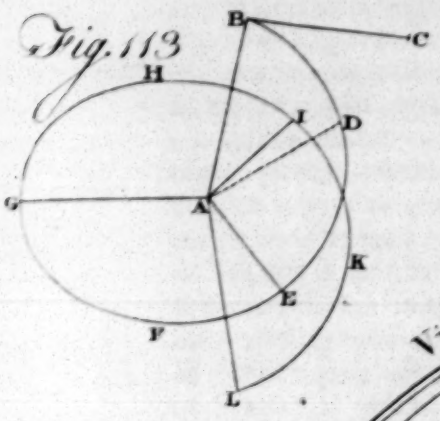


Fig. 116

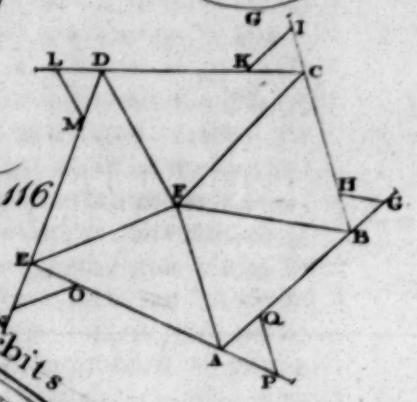


Fig. 119

View of the proportional Magnitudes of the Planetary Orbits

Orbit of the Georgium Sidus

Proportional Magnitudes of the Primary Planets

Saturn ♄

Jupiter ♃

Georgium Sidus

Mars ♂

Earth ♁

Venus ♀

Mercury ☿

Apparent Magnitudes of the Sun seen from each Planet

From Mercury

From Venus

From Earth

From Mars

From Jupiter

From Saturn

From Georgium Sidus

NB The proportional Magnitude of the Sun, with respect to the figures of the Planets here given, is represented by the Arcle of Saturns Orbit marked ♄

Fig. 117

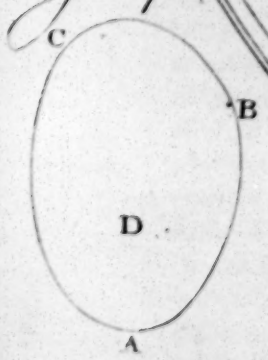
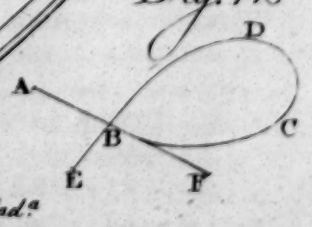


Fig. 118



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Conclusions from the foregoing Appearances.

solar system for its centre. The most proper method therefore of finding out the direction of the motion of the sun is, to divide our observations on the systematical parallax of the fixed stars into three principal zones. These, for the convenience of fixed instruments, may be assumed so as to let them pass around the equator and the solstitial colures, every one being at rectangles to the other two, according to the three dimensions of solids." Our author, then, having informed us that observations on double stars are most proper for ascertaining this point, gives an account of three zones he has marked out for this purpose; the equatorial zone, containing 150 double stars; that of the equinoctial colure, extending 10 degrees of a great circle on each side, as far as it is visible on our hemisphere, which will contain about 70 double stars; and that of the solstitial colure, including 120, besides a zone of the ecliptic containing a great many double stars which may undergo occultations by the moon. It is of the same extent, and includes about 120 double stars.

To apply this theory, it is necessary, in the first place to observe, that the rules of philosophising direct us to refer all phenomena to as few and simple principles as are sufficient to explain them. Astronomers, therefore, having already observed what they call a proper motion in several of the fixed stars, and which may be supposed common to them all, ought to resolve it, as far as possible, into a single and real motion of the solar system, as far as that will answer the known facts, and only to attribute to the proper motion of each particular star the deviations from the general law which the stars seem to follow.

237 Proper motions of some of the stars.

Dr Maskelyne informs us, that the proper motions in right ascension of Sirius, Castor, Procyon, Pollux, Regulus, Arcturus, and α Aquilæ, are as follow.— 0″.63;— 0″.28; 0″.80—0″.93;— 0″.41;— 1″.40, and + 0″.57. Two of them, Sirius and Arcturus, have also a change of declination; viz. 1′.20 and 2″.01; both southward. Let now fig. 104. represent an equatorial zone with the abovementioned stars referred to it, according to their respective right ascensions, having the solar system in its centre. Assume the direction AB from a point somewhere not far from the 77th degree of right ascension to its opposite 257th degree, and suppose the sun to move in that direction from S towards B, then will that one motion answer that of all the stars together; for if the supposition be true, Arcturus, Regulus, Pollux, Procyon, Castor, and Sirius, should appear to decrease in right ascension, while α Aquilæ, on the contrary, should appear to increase. Moreover, suppose the sun to ascend at the same time, in the same direction, towards some point in the northern hemisphere, for instance towards the constellation Hercules; then will also the observed change of declination of Sirius and Arcturus be resolved into the single motion of the system. Many difficulties indeed yet remain; such as the correspondence of the exact quantity of motion observed in each star, with what will be assigned to it by this hypothesis. But it is to be remembered, that the very different and still unknown distances of the fixed stars must, for a good while yet, leave us in the dark as to the strict application of the theory; and that any deviation from it may easily be accounted for from the still unknown *real* proper motion of the stars; for if the solar system have in reality the motion now ascribed to it, then what astronomers have already observed concerning the change of place of the stars, and have called their proper motion, will become only an *apparent* motion; and future observations must still point out, by the deviations from the general law, which the stars will follow in those apparent motions, what may be their real proper motions, as well as relative distances. "But (says Mr Herschel) lest I should be censured for admitting so new and capital a motion upon too slight a foundation, I must observe that the concurrence of those seven principal stars cannot but give some value to an hypothesis that will simplify the celestial motions in general. We know that the sun, at the distance of a fixed star, would appear like one of them; and from analogy we conclude the fixed stars to be suns. Now, since the apparent motions of those seven stars may be accounted for, either by supposing them to move in the manner they appear to do, or else by supposing the sun alone to have a motion in a direction some how not far from that which I have assigned to it, I think we are no more authorised to suppose the sun at rest than we should be to deny the diurnal motion of the earth; excepting in this respect, that the proofs of the latter are very numerous, whereas the former rest only on a few, though capital testimonies."

Conclusions from the foregoing Appearances.

238 Change of right ascension and declination of twelve stars.

The following table, taken from De la Lande, of the change of right ascension and declination of twelve stars, is brought as an additional proof of this doctrine.

Names of Stars.	Change of R. A.	Change of Declin.
Arcturus	— 1′ 11″	— 1′ 55″
Sirius	— 37	— 52
β Cygni	— 3	+ 49
Procyon	— 33	— 47
ϵ Cygni	+ 20	+ 34
γ Arietis	— 14	— 29
γ Gemini	— 8	— 24
Aldebaran	+ 3	— 18
β Gemini	— 48	— 16
γ Piscium	+ 53	+ 7
α Aquilæ	+ 32	— 4
α Gemini	— 24	— 1

Fig. 105. represents them projected on the plane of the equator. They are all in the northern hemisphere except Sirius, which must be supposed to be viewed in the concave part of the opposite half of the globe, while the rest are drawn on the convex surface. Regulus being added to that number, and Castor being double, we have 14 stars; and every star's motion, except Regulus, being assigned in declination as well as right ascension, we have no fewer than 27 given motions to account for. Now, by assuming a point somewhere near λ Herculis, and supposing the sun to have a proper motion towards that part of the heavens, we shall account for 22 of these motions. For β Cygni, α Aquilæ, ϵ Cygni, γ Piscium, γ Arietis, and Aldebaran, ought, upon the supposed motion of the sun, to have an apparent progression according to the hour-circle XVIII, XIX, XX, &c. or to increase in right ascension; while Arcturus, Regulus, the two stars of α Geminorum, Pollux, Procyon, Sirius, and γ Geminorum, should apparently go back in the order XVI, XV, XIV, &c. of the hour-circle, so as to decrease in right ascension. But according to De la Lande's table, excepting β Cygni and γ Arietis, all these motions

239 Motions of the stars accounted for.

Conclusions from the foregoing Appearances.

tions really take place. With regard to the change of declination, every ſtar in the table ſhould go towards the ſouth; and here we find but three exceptions, in β and ε Cygni and γ Piſcium. So that, upon the whole, we have but five deviations out of 27 known motions, which this hypotheſis will not account for; and theſe exceptions muſt be reſolved into the real proper motion of the ſtars.

240 Of the velocity of the ſtars.

Some circumſtances in the quantity of theſe motions alſo deſerve our notice. In the firſt place, Arcturus and Sirius being the largeſt of the ſtars, and therefore probably the neareſt, ought to have the greateſt apparent motion, both in right aſcenſion and declination; which is agreeable to obſervation, as appears from the table. 2. With regard to the right aſcenſion only, Arcturus being better ſituated to ſhow its motion, ought to have it much greater; as we find it actually has. Aldebaran, both badly ſituated and conſiderably ſmaller, ought, according to the ſame rule, to ſhow but little motion, &c.; all of which is conformable to the table. A very ſtriking agreement with the hypotheſis may be alſo obſerved in Caſtor and Pollux, both of which are pretty well ſituated; and accordingly we find that Pollux, for the ſize of the ſtar, ſhows as much motion in right aſcenſion as we could expect; though it is remarkable that Caſtor, though equally well placed, ſhows no more than half the motion by the table. This is ſeemingly contrary to the hypotheſis: but it muſt be remembered, that Caſtor is a double ſtar, and the two of which it conſiſts are nearly equal to each other in luſtre; ſo that, as we can allow only half the light to each, there is a ſtrong preſumption of their being at twice the diſtance of Pollux, which agrees very well with obſervation. It might alſo be obſerved, that we ſhould be involved in great difficulty by ſuppoſing the motion of Caſtor really to be in the ſtar: for how extraordinary muſt be the concurrence, that two ſtars, viz. thoſe that make up this apparently ſingle one, ſhould both have a proper motion ſo exactly alike, that in all our obſervations hitherto, we have not found them diſagree a ſingle ſecond either in right aſcenſion or in declination for 50 years together?

241 Arguments from the obſervations of Mr Mayer in favour of Herſchel's hypotheſis

In a poſtſcript to this paper on the motion of the ſolar ſyſtem, Mr Herſchel brings ſeveral additional confirmations of his hypotheſis from the works of Mr Mayer. Theſe contain a catalogue of the places of 80 ſtars obſerved by Mr Mayer in 1756, and whoſe places he compared with thoſe of the ſame ſtars given by Roemer in 1706. From the goodneſs of the inſtrument with which Mr Roemer made his obſervations, Mr Mayer gives it as his opinion, that where the diſagreement in the place of a ſtar is but ſmall, it may be attributed to the imperfection of the inſtrument; but that when it amounts to 10″ or 15″, it is a very probable indication of motion in ſuch a ſtar; and he adds, that when the diſagreement is ſo much as in ſome ſtars which he names (among which is *Fomahand*, where the difference is 21″ in 50 years), he has not the leaſt doubt of a proper motion. The following tables are extracted from Mr Mayer's work; one contains the ſtars whoſe motion agrees with Mr Herſchel's hypotheſis; the other thoſe that diſagree with it, and whoſe phenomena muſt therefore be either aſcribed to a proper motion of the ſtars themſelves, or to ſome other more hidden cauſe.

242 Tables of moving ſtars.

TABLE I.

Names of Stars.	Motion in R. A.	Motion in Declin.
β Ceti	+ 32	- -
α Arietis	+ 10	- -
δ Ceti	+ 15	- -
α Ceti	+ 16	- -
α Perſei	+ 16	- -
8 Pleiadum	- -	— 16
γ Eridani	+ 14	- -
ε Tauri	- -	— 11
α Aurigæ	+ 11	— 11
β Orionis	inſenſ.	inſenſ.
β Tauri	— 11	— 13
ζ Hydræ	— 23	- -
γ Leporis	- -	— 10
ε Urſæ Majoris	— 33	+ 10
α Serpentis	inſenſ.	- -
γ Draconis	+ 12	- -
α Lyræ	inſenſ.	+ 14
γ Aquilæ	- -	— 20
γ Capricorn	+ 19	- -
ε Pegaſi	- -	— 28
δ Capricorn	+ 24	— 17
α Aquar.	+ 13	- -
α Orionis	inſenſ.	— 11
μ Geminorum	— 16	- -
ε Navis	— 13	— 11
β Cancri	- -	— 14
ε Urſa Majoris	— 54	- -
ζ Pegaſi	- -	— 13
Fomahand	+ 21	- -
β Pegaſi	+ 12	- -
α Androm.	- -	— 21
β Caſſiopeiæ	+ 34	- -

Conclusions from the foregoing Appearances.

TABLE II.

Names of Stars.	Motion in R. A.	Motion in Declin.
Polaris	- -	+ 13
γ Ceti	— 14	- -
β Perſei	— 10	- -
α Leporis	- -	+ 11
μ Geminor.	- -	+ 15
ε Canis Major	- -	+ 10
ζ Hydræ	- -	+ 24
α Hydræ	- -	+ 13
β Herculis	+ 14	- -
γ Cygni	— 13	- -
ε Pegaſi	— 14	- -
ζ Pegaſi	— 20	- -

"From the firſt table, (ſays Mr Herſchel), we gather that the principal ſtars, Lucida, Lyræ, Capella, α Orionis, Rigel, Fomahand, α Serpentarii, α Aquarii, α Arietis, α Perſei, α Andromedæ, α Tauri, α Ceti, and 20 more of the moſt diſtinguiſhed of the ſecond and third rank of the ſtars, agree with our propoſed ſolar motion, when, on the contrary, the ſecond table contains but a few ſtars, and not a ſingle one of the firſt magnitude among them to oppoſe it. It is alſo remarkable, that many ſtars of the firſt table agree both in right aſcenſion and declination with the ſuppoſition of a ſolar motion; whereas there is not one among thoſe of the ſecond table which oppoſes it in both directions. This ſeems to indicate, that the ſolar motion, in ſome

of

Conclusions from the foregoing Appearances.

of them at leaſt, has counteracted and thereby deſtroyed, the effect of their own proper motion in one direction, ſo as to render it inſenſible; otherwiſe it would appear improbable, that eight ſtars out of twelve, contained in the latter table ſhould only have a motion at rectangles, or in oppoſition to any one given direction. The ſame may alſo be ſaid of 19 ſtars of the former table, that only agree with the ſolar motion one way, and are as to ſenſe at reſt in the other direction; but theſe ſingularities will not be near ſo remarkable when we have the motion of the ſun to compound with their own proper motions.

The motions of α Lyræ and ε Urſæ Majoris towards the north, are placed in the firſt table: to underſtand the reaſon of which, it will be neceſſary to point out the general law by which the apparent declinations of the ſtars at preſent under conſideration are governed. Let an arch of 90° be applied to a ſphere repreſenting the fixed ſtars, ſo as always to paſs through the apex of the ſolar motion: then, while one end of it is drawn along the equator, the other will deſcribe on the ſpherical ſurface a curve which will paſs through the pole of the equator, and return into itſelf at the apex. This curve, not taken notice of by other authors, Mr Herſchel calls a *ſpherical conchoid*, from the manner in which it is generated. The law then is, that all the ſtars in the northern hemiſphere, ſituated within the nodated part of the conchoid, will ſeem to go to the north by the motion of the ſolar ſyſtem towards its apex, the reſt will appear to go ſouthwards. A ſimilar curve is to be delineated in the ſouthern hemiſphere. Mr Herſchel then ſhows a method of finding whether any ſtar, whoſe place in the heavens is known, will fall without or within the conchoid; after which he accounts for the want of ſenſible motion in α Lyræ and α Orionis in right aſcenſion, and of Rigel both in right aſcenſion and declination, in the following manner: "Theſe ſtars are ſo bright, that we may reaſonably ſuppoſe them to be among thoſe that are neareſt to us; and if they had any conſiderable motion, it would moſt likely have been diſcovered, ſince the variations of Sirius, Arcturus, Procyon, Caſtor, and Pollux, &c. have not eſcaped our notice. Now, from the ſame principle of the motion of the ſolar ſyſtem, by which we have accounted for the apparent *motion* of the latter ſtars, we may account for the apparent *reſt* of the former. Thoſe two bright ſtars, α Lyræ and α Orionis, are placed ſo near the direction of the aſſigned ſolar motion, that from the application of the ſecond theorem (n° 236), their motion ought to be inſenſible in right aſcenſion, and not very conſiderable in declination; all which is confirmed by obſervations. With reſpect to Rigel and α Serpentarii, admitting them both as ſtars large enough to have ſhown a proper motion, were their ſituation otherwiſe than it is, we find that they alſo ſhould be apparently at reſt in right aſcenſion; and Rigel, having ſouthern declination, and being a leſs conſiderable ſtar than α Orionis, which ſhows but 11″ motion towards the ſouth in 50 years, its apparent motion in declination may on that account be alſo too ſmall to become viſible." Our author concludes with a remarkable paſſage from Mayer, to the following purpoſe, viz. "if it be poſſible that the ſun has any proper motion of his own, the ſtars in that part of the heavens towards which he moves, muſt appear to open and recede from each other, while on the other hand, thoſe on the oppoſite ſide will ſeem to contract their diſtances, and come nearer each other." "Now (ſays Mr Herſchel), if we recollect what has been ſaid of the motion of the ſtars, we find that thoſe towards which I ſuppoſe the ſolar ſyſtem to move, do really recede from each other: for inſtance, Arcturus from α Lyræ, α Aquilæ and α Aquarii from α Serpentarii and ε Urſæ Majoris; and, on the contrary, thoſe in the oppoſite part of the heavens do really come nearer each other, as Sirius to Aldebaran, Procyon to α Arietis, Caſtor, Pollux, Regulus, &c. to α Ceti, α Perſei, α Andromedæ, &c. It muſt be added however, that we cannot expect immediately to perceive any effects of this motion, excepting in ſuch ſtars as are neareſt to us. But as we have at preſent no other method of judging of the relative diſtance of the fixed ſtars than from their apparent brightneſs, thoſe that are moſt likely on that account to be affected by a parallax ariſing from the motion of the ſolar ſyſtem, are the very ſtars which have been pointed out from Mayer's own table."

Conclusions from the foregoing Appearances.

243 To delineate the apparent motions of the ſtars.

244 Spherical conchoid deſcribed.

245 Velocity of the ſolar ſyſtem.

With regard to the quantity of motion in the ſolar ſyſtem, or the velocity with which the ſun and planets change their places in abſolute ſpace, Mr Herſchel propoſes only a few diſtant hints. "From the annual parallax of the fixed ſtars (ſays he), which from my own obſervations I find much leſs than it has hitherto been thought to be, we may certainly admit that the diameter of the earth's orbit, at the diſtance of Sirius or Arcturus, would not nearly ſubtend an angle of one ſecond; but the apparent motion of Arcturus, if owing to a tranſlation of the ſolar ſyſtem, amounts to no leſs 2″.7 a-year, as will appear if we compound the two motions of 1′ 11″ in right aſcenſion, and 1′ 55″ in declination into one ſingle motion, and reduce it into an annual quantity. Hence we may, in a general way eſtimate, that the ſolar motion can certainly not be leſs than that which the earth has in her annual orbit."

Sect. IV. *Of the different Syſtems by which the Celeſtial Phenomena have been accounted for.*

In treating of the various ſyſtems which have been invented in different ages, we do not mean to give an account of the various abſurdities that have been broached by individuals on this ſubject; but ſhall confine ourſelves to thoſe ſyſtems which have been of conſiderable note, and been generally followed for a number of years. Concerning the opinions of the very firſt aſtronomers about the ſyſtem of nature, we are neceſſarily as ignorant as we are of thoſe aſtronomers themſelves. Whatever opinions are handed down to us, muſt be of a vaſtly later date than the introduction of aſtronomy among mankind. If we may hazard a conjecture, however, we are inclined to think that the firſt opinions on this ſubject were much more juſt than thoſe that were held afterwards for many ages.

246 Pythagorean ſyſtem.

We are told that Pythagoras maintained the motion of the earth, which is now univerſally believed, but at that time appears to have been the opinion of only a few detached individuals of Greece. As the Greeks borrowed many things from the Egyptians, and Pythagoras had travelled into Egypt and Phenice, it is probable he might receive an account of this hypotheſis from thence; but whether he did ſo or not, we have

Of the different systems by which the Celestial Phenomena have been accounted for.

now no means of knowing, neither is it of any importance whether he did or not. Certain it is, however, that this opinion did not prevail in his days, nor for many ages after. In the 2d century after Christ, the very name of the Pythagorean hypothesis was suppressed by a system erected by the famous geographer and astronomer Claudius Ptolemæus. This system, which commonly goes by the name of the *Ptolemaic*, he seems not to have originally invented, but adopted as the prevailing one of that age; and perhaps made it somewhat more consistent than it was before. He supposed the earth at rest in the centre of the universe. Round the earth, and the nearest to it of all the heavenly bodies, the moon performed its monthly revolutions. Next to the moon was placed the planet Mercury; then Venus; and above that the Sun, Mars, Jupiter, and Saturn, in their proper orbits; then the sphere of the fixed stars; above these, two spheres of what he called *chrystalline* heavens; above these was the primum mobile, which, by turning round once in 24 hours, by some unaccountable means or other, carried all the rest along with it. This primum mobile was encompassed by the empyrean heaven, which was of a cubic form, and the seat of angels and blessed spirits. Besides the motions of all the heavens round the earth once in 24 hours, each planet was supposed to have a particular motion of its own; the moon, for instance, once in a month, performed an additional revolution, the sun in a year, &c. See Fig. 150.

247 Suppressed by the Ptolemaic.

248 Ptolemy's system insufficient.

It is easy to see, that, on this supposition, the confused motions of the planets already described could never be accounted for. Had they circulated uniformly round the earth, their apparent motion ought always to have been equal and uniform, without appearing either stationary or retrograde in any part of their courses. In consequence of this objection Ptolemy was obliged to invent a great number of circles, interfering with each other, which he called *epicycles* and *eccentrics*. These proved a ready and effectual salvo for all the defects of his system; as whenever a planet was deviating from the course it ought on his plan to have followed, it was then only moving in an epicycle or an eccentric, and would in due time fall into its proper path. As to the natural causes by which the planets were directed to move in these epicycles and eccentrics, it is no wonder that he found himself much at a loss, and was obliged to have recourse to divine power for an explanation, or, in other words, to own that his system was unintelligible.

249 Pythagorean system revived by Copernicus

This system continued to be in vogue till the beginning of the 16th century, when Nicolaus Copernicus, a native of Thorn (a city of regal Prussia), and a man of great abilities, began to try whether a more satisfactory manner of accounting for the apparent motions of the heavenly bodies could not be obtained than was afforded by the Ptolemaic hypothesis. He had recourse to every author upon the subject, to see whether any had been more consistent in explaining the irregular motions of the stars than the mathematical schools: but he received no satisfaction, till he found first from Cicero, that Nicetas the Syracusan had maintained the motion of the earth; and next from Plutarch, that others of the ancients had been of the same opinion. From the small hints he could obtain from the ancients, Copernicus then deduced a most complete system, capable of solving every phenomenon in a satisfactory manner. From him this system hath ever afterwards been called the *Copernican*, and represented fig. 152. Here the sun is supposed to be in the centre; next him revolves the planet Mercury, then Venus; next, the Earth, with the Moon; beyond these, Mars, Jupiter, and Saturn; and far beyond the orbit of Saturn, he supposed the fixed stars to be placed, which formed the boundaries of the visible creation.

Of the different systems by which the Celestial Phenomena have been accounted for.

250 Tychonic system.

Though this hypothesis afforded the only natural and satisfactory solution of the phenomena which so much perplexed Ptolemy's system, it met with great opposition at first; which is not to be wondered at, considering the age in which he lived. Even the famous astronomer Tycho Brache could never assent to the earth's motion, which was the foundation of Copernicus's scheme. He therefore invented another system, whereby he avoided the ascribing of motion to the earth, and at the same time got clear of the difficulties with which Ptolemy was embarrassed. In this system, the earth was supposed the centre of the orbits of the sun and moon; but the sun was supposed to be the centre of the orbits of the five planets; so that the sun with all the planets were by Tycho Brache supposed to turn round the earth in order to save the motion of the earth round its axis once in 24 hours. This system was never much followed, the superiority of the Copernican scheme being evident at first sight. Fig. 151.

251 Inquiries concerning the causes of the planetary motions.

The system of Copernicus coming soon into universal credit, philosophers began to inquire into the causes of the planetary motions; and here, without entering upon what has been advanced by detached individuals, we shall content ourselves with giving an account of the three famous systems, the Cartesian, the Newtonian, and what is sometimes called the *Mechanical* system.

252 Cartesian system.

Des Cartes, the founder of that system which since his time has been called the *Cartesian*, flourished about the beginning of the 17th century. His system seems to have been borrowed from the philosophers Democritus and Epicurus; who held, that every thing was formed by a particular motion of very minute bodies called *atoms*, which could not be divided into smaller parts. But though the philosophy of Des Cartes resembled that of the Corpuscularians, in accounting for all the phenomena of nature merely from matter and motion; he differed from them in supposing the original parts of matter capable of being broken. To this property his *Materia Subtilis* owes its origin. To each of his atoms, or rather small masses of matter, Des Cartes attributed a motion on its axis, and likewise maintained that there was a general motion of the whole matter of the universe round like a vortex or whirlpool. From this complicated motion, those particles which were of an angular form, would have their angles broke off, and the fragments which were broke off being smaller than the particles from which they were abraded, behoved to form a matter of a more subtile kind than that made of large particles; and as there was no end of the abrasion, different kinds of mattter of all degrees of fineness would be produced. The finest sorts, he thought, would naturally separate themselves from the rest, and be accumulated in particular places. The finest of all would therefore be collected in the sun which was the centre of the universe, whose vortex was the whole etherial matter in the creation.

Fig. 120.

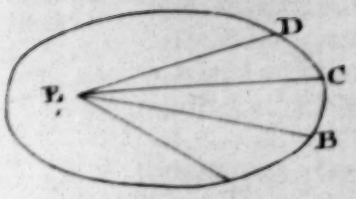


Fig. 121.

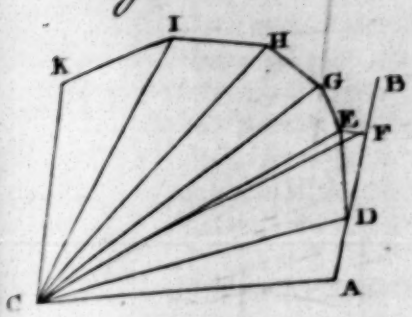


Fig. 122.

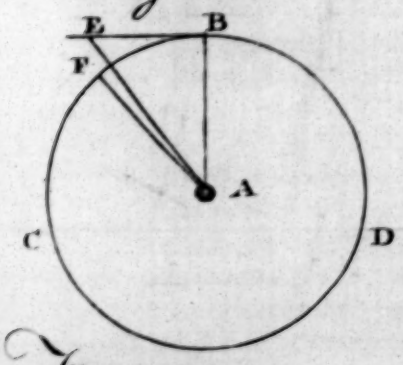


Fig. 123.

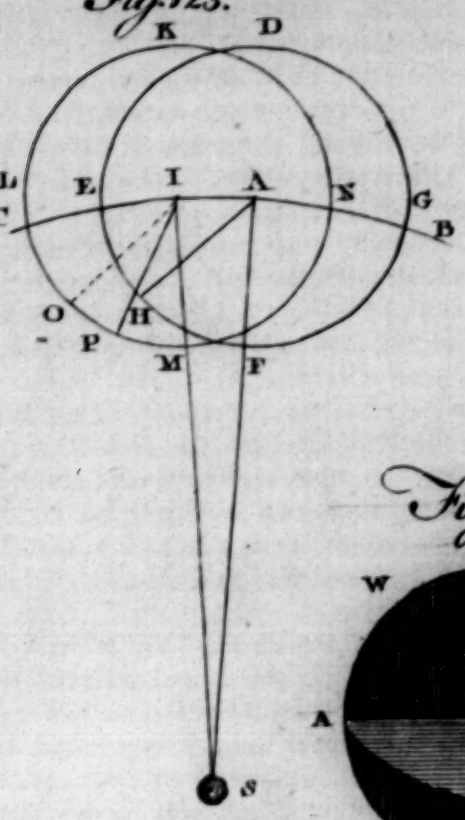


Fig. 124.

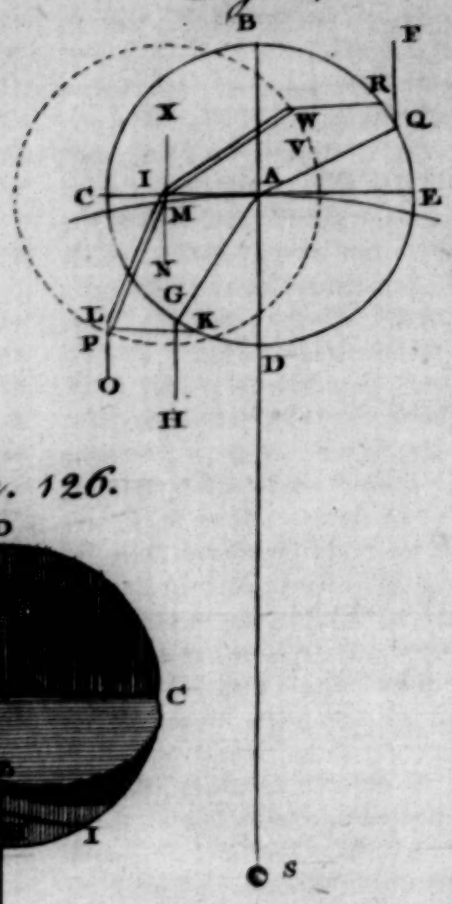


Fig. 125.

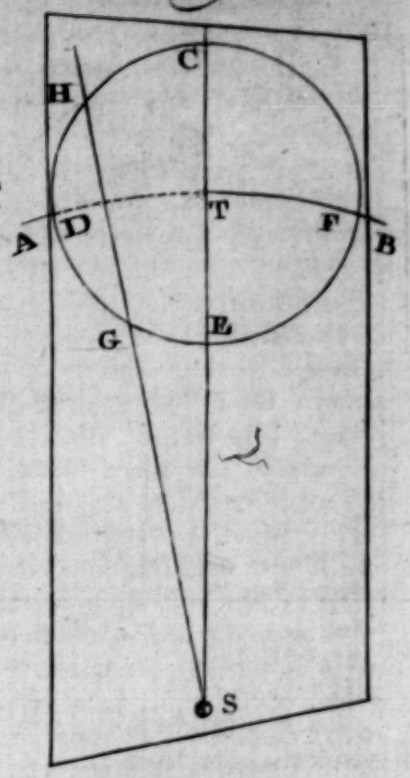


Fig. 126.

Fig. 127.

Fig. 128.

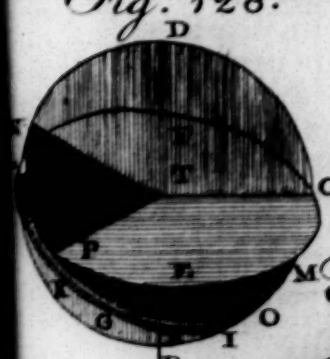


Fig. 129.

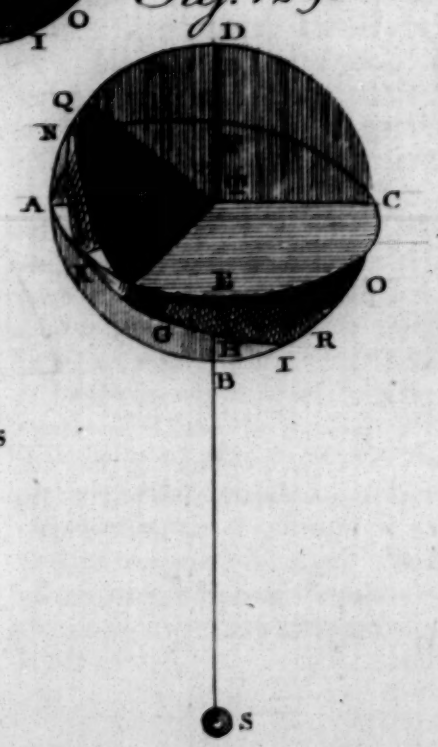


Fig. 130.

Fig. 131.

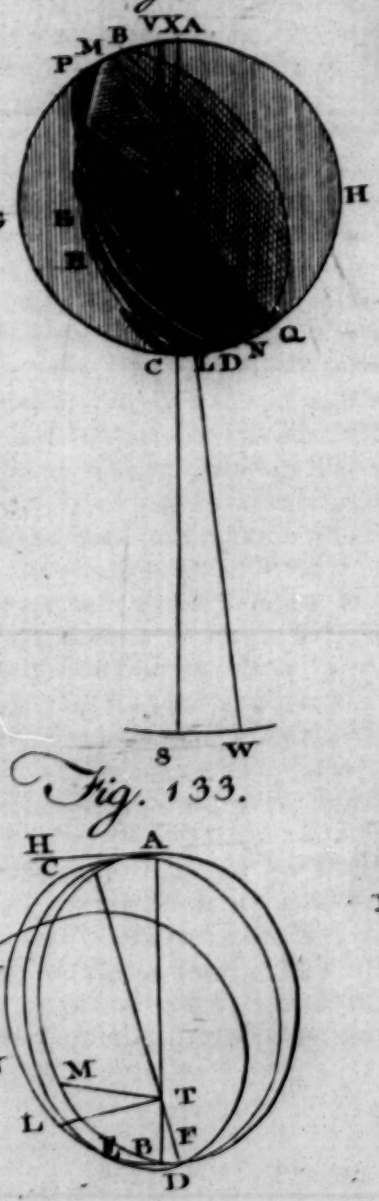


Fig. 132.

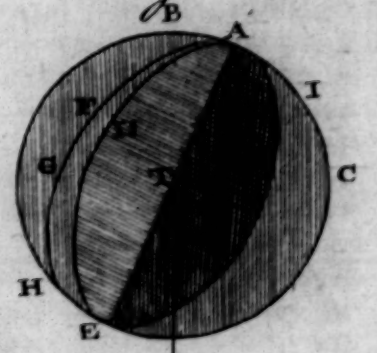
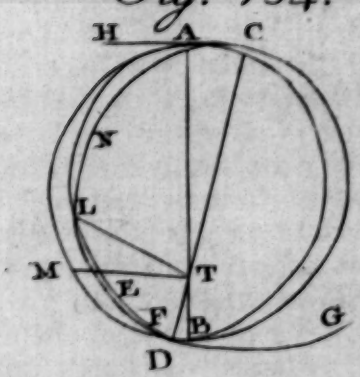


Fig. 133.

Fig. 134.



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Of the different systems by which the Celestial Phenomena have been accounted for.

ation. As all the planets were immersed in this vortex, they behoved to be carried round by it, in different times, proportioned to their distances; those which were nearest the sun circulating the most quickly; and those farthest off more slowly; as those parts of a vortex which are farthest removed from the centre are observed to circulate more slowly than those which are nearest. Besides this general vortex of the sun, each of the planets had a particular vortex of their own by which their secondary planets were carried round, and any other body that happened to come within reach of it would likewise be carried away.

It is easy to see, from this short account of Des Cartes's system, that the whole of it was mere *petitio principii*: for had he been required to prove the existence of his materia subtilis, he must undoubtedly have failed in the attempt; and hence, though his hypothesis was for some time followed for want of a better, yet it gave way to that of Newton almost as soon as it was proposed.

253 Sir Isaac Newton's system, (fig. 119.)

THE general view of the solar system given by this celebrated philosopher is not different from what has been laid down in the foregoing sections. The sun is placed in or near the centre; about whom the six planets, to which a seventh, the *Georgium Sidus*, is now added, continually move with different degrees of velocity, and at different distances. The first and nearest to the sun is Mercury, next Venus, then the Earth and Moon: beyond these is Mars; after him, Jupiter; then Saturn; and last of all, at least as far as discoveries have hitherto reached, the *Georgium Sidus*. Four of these primary planets, as they are called, are attended by moons or satellites, as well as the earth. These are, Venus* Jupiter, Saturn, and the Georgium Sidus: of whom the first has only one; the second, four; the third, five; and the fourth two, though probably there may be more yet undiscovered by reason of their smallness or distance.

* Seen° 74.

254 Orbits of the planets elliptical, &c.

Though these planets uniformly and at all times respect the sun as the centre of their motion, yet they do not always preserve the same distance from him; neither do they all move in the same plane, though every one of them revolves in an orbit whose plane if extended would pass through the sun's centre. The line in which the planes of any of the planetary orbits crosses the orbit of the earth is called the *line* of its nodes, and the points of intersection are the *nodes* themselves. Each of them moves in an orbit somewhat elliptical; and thus sometimes approaches nearer, and at others recedes farther from, the sun than before. This deviation from a circle is called the *eccentricity* of the orbit; the point where it is farthest distant from the sun is called its *aphelion*; and where nearest, the *perihelion*. The eccentricities of the different planets, however, are very different. In Saturn the proportion of the greatest distance to the least is something less than 9 to 8, but much nearer to this than 10 to 9; in Jupiter, it is something greater than that of 11 to 10; in Mars, it exceeds the proportion of 6 to 5; in the earth, it is only in the proportion of about 30 to 29; in Venus still less, being only as 70 to 69; but in Mercury it is much greater than in any of the rest, being little less than that of 3 to 2. The aphelia of all the planets are not situated on the same side of the sun, but in the positions shown fig. 106. though these positions are also variable, as shall be afterwards more fully explained. The eccentricity of the Georgium Sidus is not yet determined, though it is supposed to be less than that of the rest. All of them revolve from west to east; and the most remote is the longest of finishing its course round the sun.

255 Eccentricities, aphelia, &c. of the different planets.

Of Centripetal Powers.

256 They describe equal spaces in equal times round the sun.

Each of the planets moves in its orbit round the sun in such a manner, that the line drawn from the sun to the planet, by accompanying the planet in its motion, will describe about the sun equal spaces in equal times. There is also a certain relation between the greater axes of these ellipses and the times in which the planets perform their revolutions through them, which may be expressed in the following manner: Let the period of one planet be expressed by the letter A, the greater axis of its orbit by D; let the period of another planet be denoted by B, and the greater axis of this planet's orbit by E. Then if C be taken to bear the same proportion to B as B bears to A; likewise if F be taken to bear the same proportion to E as E bears to D, and G taken to bear the same proportion likewise to F as E bears to D; then A shall bear the the same proportion to C as D bears to G.

A D
B E
C F
G

§ 1. *Of Centripetal Powers in general.*

257 Sir Isaac's doctrine of centripetal powers.

BEFORE we attempt to give any particular explanation of the causes producing the planetary motions, it will be necessary to premise something of Sir Isaac Newton's doctrine of centripetal forces, as upon that depends his doctrine of gravitation, and of the whole celestial system. The first effect of these powers is, to cause any body projected in a straight line deviate from it, and describe an incurvated one, which shall always be bent towards the centre to which the body is supposed to have a tendency. It is not, however, necessary that the moving body should approach the centre; it may even recede farther from it notwithstanding its being drawn by it; but this property uniformly belongs to it, that the line in which it moves will be continually concave towards the centre to which the power is directed.

Let A (fig. 107.) be the centre of the force. Let a body in B be moving in the direction of the straight line BC, in which line it would continue to move if undisturbed; but being attracted by the centripetal force towards A, the body must necessarily depart from this line BC; and being drawn into the curve line BD, must pass between the lines AB and BC. It is evident, therefore, that the body in B being gradually turned off from the straight line BC, it will at first be convex towards that line and concave towards A. And that the curve will always continue to have this concavity towards A, may thus appear: In the line BC, near to B, take any point, as E, from which the line EFG may be so drawn as to touch the curve line BD in some point, as F. Now, when the body is come to E, if the centripetal power were immediately to be suspended, the body would no longer continue to move in a curve line, but, being left to itself, would forthwith reassume a straight course, and that straight course would be in the line FG; for that line is in the direction of the body's motion of the point F. But the centripetal force continuing its energy, the body will be gradually drawn from this line FG so as to keep in the

Of Centripetal Powers.

the line FD, and make that line, near the point F, to be concave towards the point A; and in this manner the body may be followed in its courſe throughout the line BD, and every part of that line be ſhown to be concave towards the point A.

Again, the point A (fig. 108.) being the centre of a centripetal force, let a body at B ſet out in the direction of the ſtraight line BC perpendicular to the line AB. It will be eaſily conceived, that there is no other point in the line BC ſo near to A as the point B; that AB is the ſhorteſt of all the lines which can be drawn from A to any part of the line BC; all others, as AD or AE, being longer than AB. Hence it follows, that the body ſetting out from it, if it moved in the line BC, it would recede more and more from the point A. Now, as the operation of a centripetal force is to draw a body towards the centre of that force, if ſuch a force act upon a reſting body, it muſt neceſſarily put that body ſo into motion as to cauſe it move towards the centre of the force: if the body were of itſelf moving towards that centre, it would accelerate that motion, and cauſe it to move faſter down; but if the body were in ſuch a motion that it would of itſelf recede from the centre, it is not neceſſary that the action of a centripetal power ſhould make it immediately approach the centre from which it would otherwiſe have receded; the centripetal force is not without effect if it cauſe the body to recede more ſlowly from that centre than otherwiſe it would have done. Thus, the ſmalleſt centripetal power, if it act on the body, will force it out of the line BC, and cauſe it to paſs in a bent line between BC and the point A, as has been already explained. When the body, for inſtance, has advanced to the line AD, the effect of the centripetal force diſcovers itſelf by having removed the body out of the line BC, and brought it to croſs the line AD ſomewhere between A and D, ſuppoſe at F. Now, AD being longer than AB, AF may alſo be longer than AB. The centripetal power may indeed be ſo ſtrong, that AF ſhall be ſhorter than AB; or it may be ſo evenly balanced with the progreſſive motion of the body that AF and AB ſhall be juſt equal; in which caſe the body would deſcribe a circle about the centre A; this centre of the force being alſo the centre of the circle.

If now the body, inſtead of ſetting out in the line BC perpendicular to AB, had ſet out in another line BG more inclined towards the line AB, moving in the curve line BH; then, as the body, if it were to continue its motion in the line BG, would for ſome time approach the centre A, the centripetal force would cauſe it to make greater advances toward that centre: But if the body were to ſet out in the line BI, reclined the other way from the perpendicular BC, and were to be drawn by the centripetal force into the curve line BK; the body, notwithſtanding any centripetal force, would for ſome time recede from the centre; ſince ſome part at leaſt of the curve line BK lies between the line BI and the perpendicular BC.

Let us next ſuppoſe a centripetal power directed toward the point A (Fig. 109.), to act on a body in B, which is moving in the direction of the ſtraight line BC, the line BC reclining off from AB. If from A the ſtraight lines AD, AE, AF, are drawn to the line CB, prolonged beyond B to G, it appears that AD is inclined to the line GC more obliquely than AB, AE more obliquely than AD, and AF than AE; or, to ſpeak more correctly, the angle under ADG is leſs than that under ABG, that under AEG is leſs than ADG, and AFG leſs than AEG. Now ſuppoſe the body to move in the curve line BHIK, it is likewiſe evident that the line BHIK being concave towards A and convex towards BC, it is more and more turned off from that line: ſo that in the point H, the line AK will be more obliquely inclined to the curve line BHIK than the ſame line AHD is inclined to BC at the point D; at the point I the inclination of the line AI to the curve line will be more different from the inclination of the ſame line AIE to the line BC at the point IE; and in the points K and F the difference of inclination will be ſtill greater; and in both, the inclination at the curve will be leſs oblique than at the ſtraight line BC. But the ſtraight line AB is leſs obliquely inclined to BG than AD is inclined towards DG: therefore, although the line AH be leſs obliquely inclined towards the curve HB than the ſame line AHD is inclined towards DG, yet it is poſſible, that the inclination at H may be more oblique than the inclination at B. The inclination at H may indeed be leſs oblique than the other, or they may be both the ſame. This depends upon the degree of ſtrength wherewith the centripetal force exerts itſelf during the paſſage of the body from B to H; and in like manner the inclinations at I and K depend entirely on the degree of ſtrength wherewith the centripetal force acts on the body in its paſſage from H to K: if the centripetal force be weak enough, the lines AH and AI drawn from the centre A to the body at H and at I, ſhall be more obliquely inclined to the curve than the line AB is inclined towards BG. The centripetal force may be of ſuch a ſtrength as to render all theſe inclinations equal; or if ſtronger, the inclinations at I and K will be leſs oblique than at B; and Sir Iſaac Newton has particularly ſhown, that if the centripetal power decreaſes after a certain manner without the increaſe of diſtance, a body may deſcribe ſuch a curve line, that all the lines drawn from the centre to the body ſhall be equally inclined to that curve line.

Of Centripetal Powers.

258 Revolution of a body round a centre explained.

We muſt farther remark, that if the centripetal power, while the body increaſes its diſtance from the centre, retain ſufficient ſtrength to make the lines drawn from the centre to the body to become at length leſs oblique to the curve; then, if this diminution of the obliquity continue, till at laſt the line drawn from the centre to the body ſhall ceaſe to be obliquely inclined to the curve, and become perpendicular thereto; from this inſtant the body ſhall no longer recede from the centre, but in its following motion ſhall again deſcend, and deſcribe a curve in all reſpects like that which it has deſcribed already, provided the centripetal power, every where at the ſame diſtance from the body, acts with the ſame ſtrength. This return of the body may be proved by the following propoſition: That if the body in any place, ſuppoſe at I, were to be ſtopped, and thrown directly backward with the velocity wherewith it was moving forward in that point I, then the body, by the action of the centripetal force upon it, would move back again over the path IHB, in which it had before advanced

Of Centripetal Powers.

vanced forward, and would arrive again at the point B in the ſame ſpace of time as was taken up in its paſſage from B to I; the velocity of the body at its return from the point B being the ſame as that wherewith it firſt ſet out from that point.

The truth of this propoſition may be illuſtrated in the following manner. Suppoſe, in fig. 110, that a body were carried after the following manner through the bent figure ABCDEF, compoſed of the ſtraight lines AB, BC, CD, DE, EF, let the body then firſt be ſuppoſed to receive an impulſe to ſome point within the concavity of the figure, as G. Now, as this body, when once moving in the ſtraight line AB, will continue to move on in this line as long as it ſhall be left to itſelf; but being diſturbed at the point B by the impulſe given it, it will be turned out of this line AB into ſome other ſtraight line, wherein it will afterwards continue to move as long as it ſhall be left to itſelf: therefore, let this impulſe have ſtrength ſufficient to turn the body into the line BC; then let the body move on undiſturbed from B to C: but at C let it receive another impulſe pointed alſo towards G, and of ſufficient ſtrength to turn the body into the line CD; at D let a third impulſe turn it into the line DE; and at E let another turn it into EF. Now, if the body, while moving on in the line EF, be ſtopped and turned back again with the ſame velocity with which it was moving forward, then by the repetition of the former impulſe at E, the body will be turned in the line ED, and move in it from E to D with the ſame velocity as that wherewith it was moving forward in this line; then by a repetition of the impulſe at D, when the body ſhall have returned to that point, it will be turned into the line DC; and by the repetition of the former impulſes at C and at B, the body will be brought back again into the line BA, with the velocity wherewith it firſt moved in that line.

To illuſtrate this ſtill further, let DE and FE be continued beyond E. In DE thus continued, take at pleaſure the length EH, and let HI be ſo drawn as to be equidiſtant from the line GE; then, from the ſecond law of motion, it follows, that after the impulſe on the body on E, it will move through the ſpace EI in the ſame time it would have employed in moving from E to H with the velocity it had in the line DE. In FE prolonged, take EK equal to EI, and draw KL equidiſtant from GE. Then becauſe the body is thrown back in the line FE with the ſame velocity with which it went forward in that line, if, when the body was returned to E, it were permitted to go ſtraight on, it would paſs through EK in the ſame time as it took up in paſſing through EI, when it went forward in the line EF. But if, at the body's return to the point E, ſuch an impulſe directed toward the point D were to be given it as was ſufficient to turn it into the line DE, it is plain that this impulſe muſt be equal to that which originally turned the body out of the line DE into EF; and that the velocity with which the body will return into the line ED is the ſame as that wherewith it moved before through this line from D to E. Becauſe EK is equal to EI, and KL and HI being each equidiſtant from GE, are by conſequence equidiſtant from each other; it follows, that the two triangular figures IEH and KEL are altogether like and equal to each other. EK therefore being equal to EI, and EL equal to KH, and KL equal to HL, it is plain, that the body, after its return to E, being turned out of the line FE into ED by an impulſe acting upon it in E after the manner abovementioned, it will receive ſuch a velocity by this impulſe as will carry it through EL in the ſame time it would have taken to go through EK, if it had paſſed through it undiſturbed. It has already been obſerved, that the time in which the body would paſs over EK, with the velocity wherewith it returns, is equal to the time it took up in going forward from E to I; that is, to the time in which it would have gone through EH with the velocity wherewith it moved from D to E: therefore the time in which the body will paſs from E to L, after its return into the line ED, is the ſame as would have been taken up by the body in paſſing through the line EH with the velocity wherewith it firſt moved in the line DE. Since, therefore EL and EH are equal, the body returns into the line DE with the velocity which it had before in that line.—Again, we may affirm, that the ſecond impulſe in E is equal to the firſt; for as the impulſe in E, whereby the body was turned out of the line DE into the line EF, is of ſuch ſtrength, that if the body had been at reſt when this impulſe had acted upon it, it would have communicated as much motion to it as would have been ſufficient to carry it through a length equal to HI, in the time wherein the body would have paſſed from E to H, or in the time wherein it paſſed from E to I. In the ſame manner on the return of the body, the impulſe in E, whereby it is turned out of the line FE into ED, is of ſuch ſtrength, that if it had acted on the body at reſt, it would have cauſed it move through a length equal to KL in the ſame time as the body would employ in paſſing through EK with the velocity wherewith it returns in the line FE: therefore the ſecond impulſe, had it acted on the body at reſt, would have cauſed it to move through a length equal to KL in the ſame ſpace of time as would have been taken up by the body in paſſing through a length equal to HI were the firſt impuſe to act on the body while at reſt. That is, the effects of the firſt and ſecond impuſe on the body when at reſt would be the ſame: for KL and HI are equal; conſequently the ſecond impuſe is equal to the firſt. Thus, if the body be returned through FE with the velocity wherewith it moved forward, it has been ſhown how, by the repetition of the impulſe which acted on it in E, the body will return again into the line DE with the velocity which it had before in that line. By the ſame method of reaſoning it may be proved, that when the body is returned back to D, the impulſe which before acted on that point will throw the body into the line DC with the velocity which it firſt had in that line; and the other impulſes being ſucceſſively repeated, the body will at length be brought back again into the line BA with the velocity wherewith it ſet out in that line.—Thus theſe impulſes, by acting over again in an inverted order all their operations on the body, bring it back again through the path in which it had proceeded forward; and this obtains equally whatever be the number of ſtraight lines whereof this curve figure is compoſed. Now, by a method of reaſoning of which Sir Iſaac Newton made much uſe, and which he introduced into geometry.

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metry, thereby greatly enriching that ſcience, we might make a tranſition from this figure, compoſed of a number ſtraight lines, to a figure of one continued curvature, and from a number of ſeparate impulſes repeated at diſtinct intervals to a continued centripetal force, and ſhow, that becauſe what has been here advanced holds univerſally true whatever be the number of ſtraight lines whereof the curve figure ACF is compoſed, and however frequently the impulſes at the angles of this figure are repeated; therefore the ſame will ſtill remain true although this figure ſhould be converted into one of a continued curvature; and theſe diſtinct impulſes ſhould be changed into a continual centripetal force.

This being allowed, ſuppoſe the body in K to have the line AK no longer obliquely inclined to its motion. In this caſe, if the body be turned back in the manner we have been conſidering, it muſt be directed back perpendicularly to AK; but if it had proceeded forward, it would likewiſe have moved in a direction perpendicular to AK: conſequently, whether it move from this point K backward or forward, it muſt deſcribe the ſame kind of courſe. Therefore, ſince by being turned back it will go over again the line KIHB, if it be permitted to go forward, the line KL, which it ſhall deſcribe, will be altogether ſimilar to the line KHB.

In like manner we may determine the nature of the motion, if the line wherein the body ſets out be inclined, as in fig. 111. down toward the line BA drawn between the body and the centre. If the centripetal power ſo much increaſes in ſtrength as the body approaches, that it can bend the path in which the body moves to that degree as to cauſe all the lines, AH, AI, AK, to remain no leſs oblique to the motion of the body than AB is oblique to BC, the body ſhall continually more and more approach the centre: But if the centripetal power increaſes in ſo much leſs a degree as to permit the line drawn from the centre to the body, as it accompanies the body in its motion, at length to become more and more erect to the curve wherein the body moves, and in the end, ſuppoſe at K, to become perpendicular to it; from that time the body ſhall riſe again. This is evident from what has been ſaid above; becauſe, for the very ſame reaſon, here alſo the body will proceed from the point K to deſcribe a line altogether ſimilar to that in which it has moved from B to K. Thus it happens as in the pendulum, which, all the time it approaches a perpendicular poſition towards the horizon, deſcends more and more; but as ſoon as it is come into that ſituation, it immediately riſes again by the ſame degrees as it deſcended before: ſo here the body more and more approaches the centre all the time it is moving from B to K; but thenceforward it riſes from the centre again by the ſame degrees as it approached before.

If, as in fig. 112. the line BC be perpendicular to AB; then as has already been obſerved, the centripetal power may be ſo balanced with the progreſſive motion of the body, that it may keep moving round the centre A conſtantly at the ſame diſtance, as the body does when whirled about any point to which it is tied by a ſtring. If the centripetal power be too weak to produce this effect, the motion of the body will preſently become oblique to the line drawn from itſelf to the centre; but if it be ſtronger, the body muſt conſtantly keep moving in a curve to which a line drawn from it to the body is perpendicular.

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If the centripetal power change with the change of diſtance, in ſuch a manner that the body, after its motion has become oblique to the line drawn from itſelf to the centre, ſhall again become perpendicular thereto; then the body ſhall, in its ſubſequent motion, return again to the diſtance of AB, and from that diſtance take a courſe ſimilar to the former: and thus, if the body move in a ſpace void of all reſiſtance, which has been all along ſuppoſed, it will continue in a perpetual motion about the centre, deſcending and aſcending from it alternately. If the body, ſetting out from B (fig. 113.) in the line BC perpendicular to AB, deſcribe the line BDE, which in D ſhall be oblique to the line AD; but in E ſhall again become erect to AE, drawn from the body in E to the centre A; then from this point E the body ſhall deſcribe the line EFG entirely ſimilar to BDE, and at G ſhall be at the ſame diſtance as it was at B; and the line AG ſhall be erect to the body's motion. Therefore the body ſhall proceed to deſcribe from G the line GHI altogether ſimilar to the line GFE, and at I it will have the ſame diſtance from the centre as it had at E; and alſo have the line AI erect to its motion: ſo that its ſubſequent motion muſt be in the line IKL ſimilar to IKG, and the diſtance AL equal to AG. Thus the body will go on in a perpetual round without ceaſing, alternately enlarging and contracting its diſtance from the centre.

If it ſo happen that the point E fall upon the line BA, continued beyond A; then the point G will fall upon B, I on E, and L alſo on B; ſo that the body will in this caſe deſcribe a ſimple curve line round the centre A, like the line BDEF in fig. 114. in which it will revolve from B to E, and from E to B, without end. If AE in fig. 113. ſhould happen to be perpendicular to AB, in this caſe alſo a ſimple line will be deſcribed; for the point G will fall on the line BA prolonged beyond A; the point I on the line AE prolonged beyond A, and the point L on B; ſo that the body will deſcribe a line like the curve line BEGI in fig. 115. in which the oppoſite points B and G are equally diſtant from A; and the oppoſite points E and L are alſo equally diſtant from the ſame point A. In other caſes the body will have a courſe of a more complicated nature.

Thus it muſt be apparent how a body, while it is conſtantly attracted towards a centre, may notwithſtanding by its progreſſive motion keep itſelf from falling down to the centre, deſcribing about it an endleſs circuit, ſometimes approaching and ſometimes receding from it. Hitherto, however, we have ſuppoſed, that the centripetal power is every where of equal ſtrength at the ſame diſtance from the centre: and this is indeed the caſe with that power which keeps the planets in their orbits; but a body may be kept on in a perpetual circuit round the centre, although the centripetal power be kept moving in any curve line whatever, that ſhall have its concavity turned every where towards the centre of the force. To illuſtrate this, we ſhall in the firſt place propoſe the caſe of a body moving the incurvated figure ABCDE (fig. 116.), which is compoſed of the ſtraight lines AB, BC, CD, DE,

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and EA; the motion being carried on in the following manner. Let the body firſt move in the line AB with any uniform velocity. When it is arrived at the point B, let it receive an impulſe directed towards any point F taken within the figure; and let the impulſe be of ſuch a ſtrength as to turn the body out of the line AB into the line BC: The body after this impulſe, while left to itſelf, will continue moving in the line BC. At C let the body receive another impulſe directed towards the ſame point F, of ſuch a ſtrength as to turn it from the line BC into CD. At D, let the body, by another impulſe, directed likewiſe to the point F, be turned out of the line CD into DE. At E let another impulſe, directed likewiſe toward the point F, turn the body from the line DE into AE: and thus the body will, by means of theſe impulſes, be carried thro' the whole figure ABCDE.

Again, when the body is come to the point A, if it there receive another impulſe directed like the reſt to the point F, and of ſuch a degree of ſtrength as to turn it into the line AB, wherein it firſt moved; the body will then return into this line with the ſame velocity it had originally. To underſtand this, let AB be prolonged beyond B at pleaſure, ſuppoſe to G; and from G let GH be drawn; which, if produced, ſhould always continue equidiſtant from BF, i. e. let GH be drawn parallel to BF, in the time, then, in which the body would have moved from B to G, had it not received a new impulſe in B: by the means of that impulſe it will have acquired a velocity which will carry it from B to H. After the ſame manner, if CI be taken equal to BH, and IK be drawn parallel to CF, the body will have moved from C to K, with the velocity which it has in the line CD, in the ſame time it would have employed in moving from C to I with the velocity it had in the line BC. Therefore, ſince CI and BH are equal, the body will move through CK in the ſame time as it would have taken up in moving from B to G with the velocity wherewith it moved through the line AB. Again, DL being taken equal to CK, and LM drawn parallel to DF, the body will, for the ſame reaſon as before, move through DM with the velocity which it has in the line DE, in the ſame time it would employ in moving through BG with its original velocity. Laſtly, if EN be taken equal to DM, and NO be drawn parallel to EF; likewiſe, if AP be taken equal to EO, and PQ be drawn parallel to AF; then the body, with the velocity wherewith it returns into the line AB, will paſs thro' AQ in the time it would have employed in paſſing through BG with its original velocity. Now as all this follows directly from what has been delivered concerning oblique impulſes impreſſed upon bodies in motion; ſo we muſt here obſerve farther, that it can be proved by geometry, that AQ will always be equal to BG; which being granted, it follows, that the body has returned into the line AB with the ſame velocity which it had when it firſt moved in that line; for the velocity with which it returns into the line AB, will carry it over the line AQ in the ſame time as would have been taken up in its paſſing over an equal line BG with the original velocity.

The concluſion naturally deduced from the above reaſoning is, that by means of a centripetal and projectile force, a body may be carried round any fixed point in a curve figure which ſhall be concave towards it, as that marked ABC, fig. 117. and when it is returned to that point from whence it ſet out, it ſhall recover again the velocity with which it departed from that point. It is not indeed always neceſſary that it ſhould return again into its firſt courſe, for the curve line may have ſome ſuch figure as ABCDBE in fig. 118. In this curve line, if the body ſet out from B in the direction BF, and moved through the line BCD till it returned to B; here the body would not enter again into the line BCD, becauſe the two parts BD and BC of the curve line make an angle at the point B: ſo that the centripetal power, which at the point B would turn the body from the line BF into the curve, will not be able to turn it into the line BC from the direction in which it returns to the point B. A forcible impulſe muſt be given the body in the point B to produce that effect. If, at the point B, whence the body ſets out, the curve line return into itſelf, as in fig. 117. then the body, upon its arrival again at B, may return into its former courſe, and thus make an endleſs circuit about the centre.

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259 A body may be moved in any curvilinear direction by means of centripetal force.

260 Calculation of the force requiſite to carry a body in any curve line.

The force requiſite to carry a body in any curve line propoſed, is to be deduced from the curvature which the figure has in any part of it. Sir Iſaac Newton has laid down the following propoſition as a foundation for diſcovering this, viz. that if a line be drawn from ſome fixed point to the body, and remaining by one extreme united to that point, it be carried round along with the body; then if the power whereby the body is kept in its courſe be always pointed to this fixed point as a centre, this line will move over equal ſpaces in equal portions of time. Suppoſe a body were moving through the curve line ABCD (fig. 120), and paſſed over the arches AB, BC, CD in equal portions of time; then if a point, as E, can be found, from whence the line EA being drawn to the body in accompanying it in its motion, it ſhall make the ſpaces EAB, EBC, and ECD, over which it paſſes, equal where the times are equal; then is the body kept in this line by a power always pointed to E as a centre. To prove this, ſuppoſe a body ſet out from the point A, fig. 121. to move in the ſtraight line AB; and after it had moved for ſome time in that line, it were to receive an impulſe directed to ſome point, as C. Let it receive that impulſe at D, and thereby be turned into the line DE; and let the body, after this impulſe, take the ſame time in paſſing from D to E that is employed in paſſing from A to D. Then the ſtraight lines CA, CD, and CE being drawn, the triangular ſpaces CAD and CDE are proved to be equal in the following manner. Let EF be drawn parallel to CD. Then, it follows, from the ſecond law of motion, that ſince the body was moving in the line AB when it received the impulſe in the direction DC, it will have moved after the impulſe through the line DE in the ſame time as it would have moved through DF, provided it had received no diſturbance in D. But the time of the body's moving from D to E is ſuppoſed to be equal to the time of its moving through AD; therefore the time which the body would have employed in moving through DF, had it not been diſturbed in D, is equal to the time wherein it moved through AD; conſequently DF is equal in length to AD; for if the body had gone on to move through the line AB without inter-

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interruption, it would have moved through all the parts of it with the ſame velocity, and have paſſed over equal parts of that line in equal portions of time. Now CF being drawn, ſince AD and DF are equal, the triangular ſpace CDF is equal to the triangular ſpace CAD. Farther, the line EF being parallel to CD, it follows from the 37th propoſition of Euclid's firſt book, that the triangle CED is equal to the triangle CFD: therefore the triangle CED is equal to the triangle CAD.

In like manner, if the body receive at E another impulſe directed toward the point C, and be turned by that impulſe into the line EG; if it move afterwards from E to G in the ſame ſpace of time as was taken up by its motion from D to E, or from A to D; then CG being drawn, the triangle CEG is equal to CDE. A third impulſe at G, directed as the two former to C, whereby the body ſhall be turned into the line GH, will have alſo the like effect with the reſt. If the body move over GH in the ſame time as it took up in moving over EG, the triangle CGH will be equal to the triangle CEG. Laſtly, if the body at H be turned by a freſh impulſe directed toward C into the line HI, and at I by another impulſe directed alſo to C be turned into the line IK; and if the body move over each of the lines HI and IK in the ſame time as it employed in moving over each of the preceding lines AD, DE, EG, and GH: then each of the triangles CHI and CIK will be equal to each of the preceding. Likewiſe, as the time in which the body moves over ADE is equal to the time of its moving over EGH, and to the time of its moving over HIK; the ſpace CADE will be equal to the ſpace CEGH and to the ſpace CHIK. In the ſame manner, as the time in which the body moved over ADEG is equal to the time of its moving over GHIK, ſo the ſpace CADEG will be equal to the ſpace CGHIK. From this principle Sir Iſaac Newton demonſtrates the above-mentioned propoſition, by making the tranſition from this incurvated figure compoſed of ſtraight lines, to a figure of continued curvation; and by ſhowing, that ſince equal ſpaces are deſcribed in equal times, in this preſent figure compoſed of ſtraight lines, the ſame relation between the ſpaces deſcribed and the times of their deſcription will alſo have place in a figure of one continued curvature. He alſo deduces from this propoſition the reverſe of it; and proves, that whenever equal ſpaces are continually deſcribed, the body is acted upon by a centripetal force directed to the centre at which the ſpaces terminate.

Having thus endeavoured to illuſtrate the fundamental principle of the Newtonian philoſophy, at leaſt as far as it regards the motion of the planets and heavenly bodies, we ſhall now proceed to the more particular application of it. The firſt thing undertaken by Sir Iſaac in order to explain thoſe motions, is to demonſtrate, that in the celeſtial ſpaces there is no ſenſible matter. That the heavenly bodies ſuffer no ſenſible reſiſtance from any matter of this kind, is evident from the agreement betwixt aſtronomical obſervations in all ages with regard to the time in which the planets have been found to perform their revolutions. Des Cartes, however, was of opinion, that the planets might be kept in their courſes by means of a fluid matter,

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which continually circulating round, ſhould carry the planets along with it; and there is one appearance which ſeems to favour this opinion, viz. that the ſun turns round his axis the ſame way the planets move; the earth alſo turns round its axis the ſame way as the moon turns round the earth, and the planet Jupiter turns round his axis the ſame way that his ſatellites revolve round him. It might therefore be ſuppoſed, that if the whole planetary region were filled with a fluid matter, the ſun, by turning round on his own axis, might communicate motion firſt to that part of the fluid which was contiguous, and by degrees propagate the like motion to the parts more remote. After the ſame manner the earth might communicate motion to this fluid to a degree ſufficient to carry round the moon; and Jupiter might communicate the like to the diſtance of its ſatellites. This ſyſtem has been particularly examined by Sir Iſaac Newton; who finds, that the velocities with which the parts of this fluid ſhould move in different diſtances from the centre of motion will not agree with the motions obſerved in the different planets; for inſtance, that the time of one entire circulation of the fluid wherein Jupiter ſhould ſwim, would bear a greater proportion to the time of one entire circulation of the fluid where the earth is, than the period of Jupiter bears to that of the earth. He proves alſo, that the planet cannot circulate in ſuch a fluid, ſo as to keep long in the ſame courſe, unleſs the planet and the contiguous fluid are of the ſame denſity, and the planet be carried along with the ſame velocity as the fluid. There is alſo another remark made on this motion by Sir Iſaac, viz. that ſome vivifying force will be continually neceſſary at the centre of the motion. The ſun, in particular, by communicating motion to the ambient fluid, will loſe from itſelf as much motion as it communicates to the fluid, unleſs ſome acting principle reſide in the ſun to renew its motion continually. If the fluid were infinite, this gradual loſs of motion would continue till the whole ſhould ſtop; and if the fluid were limited, this loſs of motion would continue till there would remain no ſwifter a revolution in the ſun than in the outermoſt part of the fluid, ſo that the whole would turn together about the axis of the ſun like one ſolid globe. We muſt likewiſe obſerve, that as the planets do not move in perfect circles round the ſun, there is a greater diſtance between their orbits in ſome places than others. For inſtance, the diſtance between the orbit of Mars and Venus is near half as great again in ſome part of their courſe as in others. Now here the fluid in which the earth ſhould ſwim, muſt move with a leſs rapid motion where there is this greater interval between the contiguous orbits; but, on the contrary, where the ſpace is ſtraiteſt, the earth moves more ſlowly than where it is wideſt.

Again, if our globe of earth ſwam in a fluid of equal denſity with the earth itſelf, that is, in a fluid more denſe than water, all bodies put in motion here upon the earth's ſurface muſt ſuffer a great reſiſtance by it; whereas Sir Iſaac Newton has made it evident, by experiments, that bodies, falling perpendicularly through the air, ſuffer only about one hundred and ſixtieth part of the reſiſtance from it that they meet with in water.

Theſe

Motions of the Primary Planets.

These expetiments are applied by Sir Iſaac yet farther to the general queſtion concerning the abſolute plenitude of ſpace. He objects againſt the filling of all ſpace with a ſubtile fluid, after the manner of Des Cartes, That all bodies muſt be immeaſurably reſiſted by it. And leſt it ſhould be thought that this objection might be evaded by aſcribing to this fluid ſuch very minute and ſmooth parts as might remove all adheſion or friction between them, whereby all reſiſtance would be loſt, Sir Iſaac proves, that fluids muſt reſiſt from the inactivity of their particles, and that water and the air reſiſt almoſt entirely on this account; ſo that in this ſubtile fluid, however ſmooth and lubricated the particles might be, yet if the whole were as denſe as water, it would reſiſt very near as much as water does: And whereas ſuch a fluid, whoſe parts are abſolutely cloſe together without any intervening ſpaces, muſt be a great deal more denſe than water, it muſt alſo reſiſt more in proportion to its denſity, unleſs we ſuppoſe the matter of which this fluid is compoſed not to be endowed with the ſame degree of inactivity with other matter: But if you deprive any ſubſtance of the property ſo univerſally belonging to all other matter, without impropriety of ſpeech it can ſcarce be called by this name. Sir Iſaac alſo made an experiment to try in particular, whether the internal parts of bodies ſuffered any reſiſtance; and the reſult did indeed appear to favour ſome ſmall degree of reſiſtance, but ſo very little as to leave it doubtful whether the effect did not ariſe from ſome other latent cauſe.

262 Objections to a plenum.

§ 2. *Of the Motions of the Primary Planets.*

163 Planetry motions particularly explained.

SINCE the planets thus move in a ſpace void of all reſiſtance, they would, if once ſet in motion, continue to move on for ever on a ſtraight line. We have, however, already obſerved, that the primary planets move about the ſun in ſuch a manner that a line extended from the ſun to the planet would deſcribe equal ſpaces in equal times; and this ſingle property in the planetary motions proves, that they are continually acted upon by a power directed towards the ſun as the centre. It has alſo been obſerved, that if the ſtrength of the centripetal power were ſuitably accommodated every where to the motion of any body round a centre, the body might be carried in any bent line whatever, whoſe concavity ſhould be every where turned towards the centre of that force; and likewiſe that the ſtrength of the centripetal force in each place was to he collected from the nature of the line wherein the body moved. Now ſince each of the planets moves in an ellipſis, having the ſun in one of its foci, Sir Iſaac Newton demonſtrates, that the ſtrength of this power is reciprocally in the duplicate proportion of the diſtance from the ſun. This proportion may be explained in the following manner: Suppoſe ſeveral diſtances to bear to each other the proportions of the numbers 1, 2, 3, 4, 5; that is, let the ſecond diſtance be double the firſt, the third three times, the fourth four times, and the fifth five times as great as the firſt; multiply each of theſe numbers by itſelf, and 1 multiplied by 1 produces ſtill 1, 2 multiplied by 2 produces 4, 3 by 3 produces 9, 4 by 4 produces 16, and 5 by 5 produces 25; this being done, the fractions $\frac{1}{1}$, $\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{16}$, and $\frac{1}{25}$, will reſpectively expreſs the proportion which the centripetal power in each of the following diſtances bears to the power at the firſt diſtance: for in the ſecond diſtance, which is double the firſt, the centripetal power will be one-fourth part only of the power at the firſt diſtance; at the third diſtance, the power will only be one-ninth part of the firſt power; at the fourth diſtance, the power will be only one-ſixteenth; and at the fifth diſtance only one twenty-fifth, of the firſt power. Thus is found the proportion in which the centripetal power decreaſes, as the diſtance from the ſun increaſes within the compaſs of one planet's motion. How it comes to paſs that the planet can be carried about the ſun by this centripetal power in a continual round, ſometimes riſing from the ſun, then deſcending again as low, appears from what has been already ſaid concerning centripetal forces.

264 Reciprocal duplicate proportion explained.

Motions of the Primary Planets.

265 Centripetal power proved to extend throughout the ſyſtem.

In order to know whether this centripetal power extends in the ſame proportion throughout the ſyſtem, and conſequently whether all the planets are influenced by it, Sir Iſaac inquires what relation there ought to be between the periods of the different planets, provided they were acted upon by the ſame power, decreaſing throughout in the proportion abovementioned; and he finds, that the period of each, in this caſe, would have that very proportion to the greater axis of its orbit which has been already related: which puts it beyond a doubt, that the different planets are preſſed towards the ſun in the ſame proportion to the diſtances as one planet is in its ſeveral diſtances; whence it is juſtly concluded, that there is ſuch a power acting towards the ſun in the foreſaid proportion at all diſtances from it. This power, when refered to the earth, Sir Iſaac calls *gravity*; when to the ſun, *attraction*; and to the planets, *centripetal* force. By theſe means, however, he deſigns only to ſignify a power endowed with the properties abovementioned; but by no means would have it underſtood as if theſe names referred any way to the cauſe of it.

266 Centripetal power defined.

View of Sir Iſaac Newton's Philoſophy, p. 175.

"But now (ſays Mr Pemberton) in theſe demonſtrations, ſome very minute inequalities in the motion of the planets are neglected; which is done with a great deal of judgment: for whatever be their cauſe, the effects are very inconſiderable, they being ſo exceedingly ſmall, that ſome aſtronomers have thought fit wholly to paſs them by. However, the excellency of this philoſophy, when in the hands of ſo great a geometer as our author (Sir Iſaac Newton), is ſuch, that it is able to trace the leaſt variations of things up to their cauſes. The only inequalities which have been obſerved common to all the planets are, the motion of the aphelion and the nodes. The tranſverſe axis of each orbit does not remain always fixed, but moves about the ſun with a very ſlow progreſſive motion; nor do the planets keep conſtantly in the ſame planes, but changes them and the lines by which theſe planes interſect each other by inſenſible degrees. The firſt of theſe inequalities, which is the motion of the aphelion, may be accounted for, by ſuppoſing the gravitation of the planets towards the ſun to differ a little farther from the forementioned reciprocal duplicate proportion of the diſtances: but the ſecond, which is the motion of the nodes, cannot be accounted for by any power directed towards the ſun; for no ſuch power can give it any lateral impulſe to divert it from the plane of its motion into any new plane, but of neceſſity muſt be derived from ſome other centre. Where

267 Minute variations in the planetary motions accounted for.

268 Motion of the aphelion accounted for.

Motions of the Primary Planets.

that power is lodged, remains to be discovered. Now it is proved, as shall be afterwards explained, that the three primary planets, Saturn, Jupiter, and the Earth, which have satellites revolving about them, are endowed with a power of causing bodies, in particular those satellites, to gravitate towards them with a force which is reciprocally in the duplicate proportion of their distances; and the planets are, in all respects in which they come under our consideration, so similar and alike, that there is no reason to question but that they have all the same property, though it be sufficient for the present purpose to have it proved of Jupiter and Saturn only; for these planets contain much greater quantities of matter than the rest, and proportionally exceed the others in power. But the influence of these two planets being allowed, it is evident how the planets come to shift their places continually: for each of the planets moving in a different plane, the action of Jupiter and Saturn upon the rest will be oblique to the planes of their motion, and therefore will gradually draw them into new ones. The same action of these two planets upon the rest will likewise cause a progressive motion; and therefore will gradually draw them into new ones. The same action of these two planets upon the rest will likewise cause a progressive motion of the aphelion; so that there will be no necessity for having recourse to the other cause for this motion, which was before hinted at, viz, the gravitation of the planets towards the sun differing from the exact duplicate proportion of their distances. And in the last place, the action of Jupiter and Saturn upon each other will produce in their motions the same inequalities as their joint action produces upon the rest. All this is effected in the same manner as the sun produces the same kind of inequalities and many others in the motion of the moon and other secondary planets; and therefore will be best apprehended by what is said afterwards. Those other irregularities in the motion of the secondary planets have place likewise here, but are too minute to be observable, because they are produced and rectified alternately, for the most part in the time of a single revolution; whereas the motion of the aphelion and nodes which increase continually, become sensible after a long series of years.

269 Jupiter and Saturn influence eachother's motions.

Yet some of these other inequalities are discernible in Jupiter and Saturn; in Saturn chiefly: for when Jupiter, who moves faster than Saturn, approaches to a conjunction with him, his action upon the latter will a little retard the motion of that planet; and by the reciprocal action of Saturn, he will himself be accelerated. After conjunction, Jupiter will again accelerate Saturn, and be likewise retarded in the same degree as before the first was retarded and the latter accelerated. Whatever inequalities besides are produced in the motion of Saturn by the action of Jupiter upon that planet, will be sufficiently rectified by placing the focus of Saturn's ellipsis, which should otherwise be in the sun, in the common centre of gravity of the sun and Jupiter. And all the inequalities of Jupiter's motions, caused by the action of Saturn upon him, are much less considerable than the irregularities of Saturn's motion. This one principle therefore of the planets having a power as well as the sun to cause bodies gravitate towards them, which is proved by the motion of the secondary planets to obtain in fact, explains all the irregularities relating to the planetary motions ever observed by astronomers (A).

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270 Method of correcting the planetary motions.

"Sir Isaac Newton after this proceeds to make an improvement in astronomy, by applying this theory to the farther correction of their motions. For as we have here observed the planets to possess a principle of gravitation as well as the sun; so it will be explained at large hereafter, that the third law of motion, which makes action and reaction equal, is to be applied in this case, and that the sun does not only attract each planet, but is also itself attracted by them; the force wherewith the planet is acted on bearing to the force wherewith the sun itself is acted upon at the same time, the proportion which the quantity of matter in the sun bears to the quantity of matter in the planet.

271 Sun moves round the common centre of gravity of him and the planets.

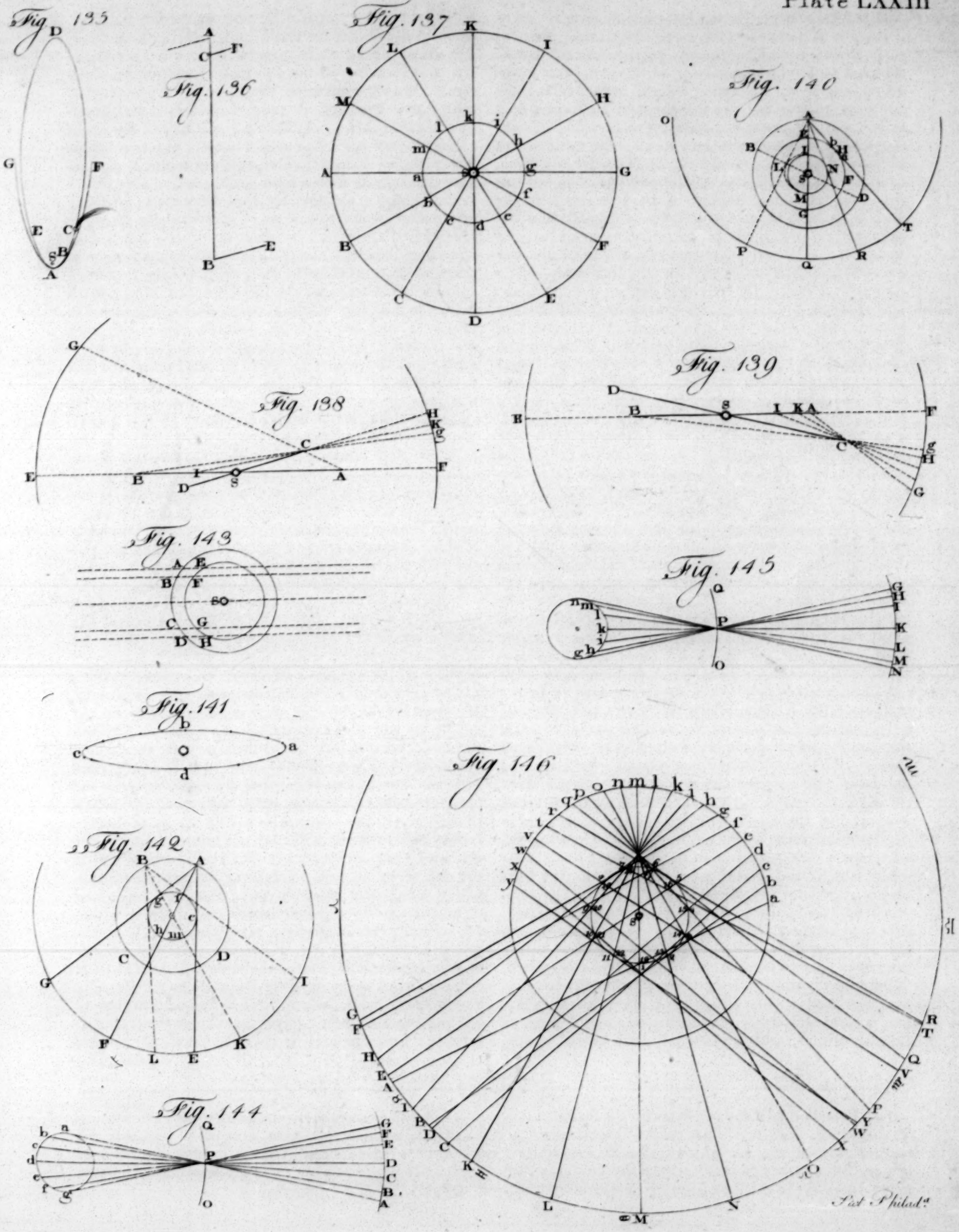
From the action of the sun and planet being thus mutual, Sir Isaac Newton proves that the sun and planet will describe about their common centre of gravity similar ellipses; and then, that the transverse axis of the ellipses, which would be described about the sun at rest in the same time, the same proportion as the quantity of solid matter in the sun and planet together bears to the first of two mean proportionals between this quantity and the quantity of matter in the sun only.

"It will be asked, perhaps, how this correction can be admitted, when the cause of the motions of the planets was before found, by supposing them to be the centre of the power which acted upon them? for, according to the present correction, this power appears rather to be directed to the common centre of gravity. But whereas the sun was at first concluded to be the centre to which the power acting on the planets was directed, because the spaces described in equal times round the sun were found to be equal; so Sir Isaac Newton proves, that if the sun and planet move round their common centre of gravity, yet, to an eye placed in the planet, the spaces which will appear to be described about the sun will have the same relation to the times of their description as the real spaces would if the sun were at rest. I further asserted, that, supposing the planets to move round the sun at rest, and to be attracted by a power which should every where act with degrees of strength reciprocally in the duplicate proportions of their distances; then the periods of the planets must observe the same relations to their distances as astronomers have found them to do. But here it must not be supposed, that the observations of astronomers absolutely agree without any the least difference: and the present correction will not cause a deviation

(A) Professor J. Robison, however, informs us in his paper on the *Georgium Sidus* (Edinburgh Philosophical Transactions, Vol. I.), That *all* the irregularities in the planetary motions *cannot* be accounted for from the laws of gravitation; for which reason he was obliged to suppose the existence of planets beyond the orbit of Saturn, even before the discovery of the *Georgium Sidus*. M. de la Lande also has observed some unaccountable inequalities in the motion of Saturn for more than 30 years past.

ASTRONOMY

Plate LXXIII



Sect. Philad.

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deviation from any one aſtronomer's obſervations ſo much as they differ from one another; for in Jupiter, where this correction is greateſt, it hardly amounts to the 3000th part of the whole axis.

272 Argument againſt the eternity of the world.

"Upon this head, I think it not improper to mention a reflection made by our excellent author upon theſe ſmall inequalities in the planets motions, which contains in it a very ſtrong philoſophical argument againſt the eternity of the world. It is this, that theſe inequalities muſt continually increaſe by ſlow degrees, till they render at length the preſent frame of nature unfit for the purpoſes it now ſerves. And a more convincing proof cannot be deſired againſt the preſent conſtitution's having exiſted from eternity than this, that a certain period of years will bring it to an end. I am aware, that this thought of our author has been repreſented even as impious, and as no leſs than caſting a reflection upon the wiſdom of the Author of nature for framing a periſhable work. But I think ſo bold an aſſertion ought to have been made with ſingular caution: for if this remark upon the increaſing irregularies in the heavenly motions be true in fact, as it really is, the imputation muſt return upon the aſſertor, that this does not detract from the divine wiſdom. Certainly we cannot pretend to know all the omniſcient Creator's purpoſes in making this world, and therefor cannot pretend to determine how long he deſigned it ſhould laſt; and it is ſufficient if it endure the time deſigned by the Author. The body of every animal ſhows the unlimited wiſdom of the Author no leſs, nay, in many reſpects more, than the larger frame of nature; and yet we ſee they are all deſigned to laſt but a ſmall ſpace of time.

§ 3. *The Motions of the Secondary Planets explained from the Principles laid down in* § 1.

THE excellency of the Newtonian philoſophy is diſcoverable even more in its ſolution of the motions of the ſecondary than in thoſe of the primary planets; for thus not only all the irregularities formerly diſcovered by aſtronomers in theſe motions are ſolved in a ſatisfactory manner, but ſeveral others are diſcovered of ſuch a complicated nature that they could never be diſtinguiſhed into proper heads. Theſe, however, are now not only found out from their cauſes, which this philoſophy has brought to light; but the dependence of them upon their cauſes is alſo ſhown in ſuch a perfect manner, that the degree of them may be exactly computed. Thus Sir Iſaac Newton found means to compute the moon's motion ſo exactly, that he framed a theory from which the place of that planet may at all times be computed very nearly, or altogether, as exactly as the places of the primary planets themſelves; which is much beyond what the greateſt aſtronomers could ever effect.

273 Secondaries attracted by their primaries.

The firſt thing demonſtrated of theſe ſecondary planets is, that they are drawn towards their reſpective primaries in the ſame manner as the latter are attracted by the ſun. That each ſecondary planet is kept in its orbit by a power directed towards its primary, &c. is proved from the phenomenon of the ſatellites of Jupiter and Saturn; becauſe they move in circles, as far as we can obſerve, about their reſpective primaries with an equable courſe, the primary being the centre of each orbit: and by comparing the times in which the different ſatellites of the ſame primary perform their periods, they are found to obſerve the ſame relation to the diſtances from their primary as the primary planets obſerve in reſpect of their mean diſtances from the ſun. The ſame thing holds good alſo with regard to the earth and moon: for ſhe is found to move round the earth in an ellipſis after the ſame manner as the primary planets do about the ſun, excepting only ſome ſmall irregularities in her motions, the cauſe of which will be particularly explained in what follows; whereby it will appear that they are no objections againſt the earth's acting on the moon in the ſame manner as the ſun acts on the primary planets; that is, as Jupiter and Saturn act upon their ſatellites. Motions of the Secondary Planets.

274 Power of Jupiter and Saturn diſcovered by their ſatellites.

By the number of ſatellites which move round Jupiter and Saturn, the power of each of theſe planets may be meaſured to a very conſiderable diſtance; for the diſtance of the outermoſt ſatellite in each of theſe planets exceeds ſeveral times the diſtance of the innermoſt. The force of the earth upon the moon, however, at different diſtances, is more confirmed by the following conſideration than any analogical reaſoning.

275 Gravity retains the moon in her orbit.

It will appear, that if the power of the earth by which it retains the moon in her orbit be ſuppoſed to act at all diſtances between the earth and moon, according to the rule already mentioned, this power will be ſufficient to produce upon bodies near the ſurface of the earth all the effects aſcribed to the principle of gravity. This is diſcovered by the following method. Let A (in fig. 122.) repreſent the earth, B the moon, BCD the moon's orbit; which differs little from a circle of which A is the centre. If the moon in B were left to itſelf to move with the velocity it has in the point B, it would leave the orbit, and proceed ſtraight forward in the line BE which touches the orbit in B. Suppoſe the moon would upon this condition move from B to E in the ſpace of one minute of time. By the action of the earth upon the moon, whereby it is retained in its orbit, the moon will really be found at the end of this minute in the point F, from whence a ſtright line drawn to A ſhall make the ſpace BFA in the circle equal to the triangular ſpace BEA; ſo that the moon in the time wherein it would have moved from B to E, if left to itſelf, has been impelled towards the earth from E to F. And when the time of the moon's paſſing from B to F is ſmall, as here it is only one minute, the diſtance between E and F ſcarce differs from the ſpace through which the moon would deſcend in the ſame time if it were to fall directly down from B toward A without any other motion. AB, the diſtance of the moon from the earth, is about 60 of the ſemidiameters of the latter; and the moon completes her revolution round the earth in about 27 days 7 hours and 43 minutes; therefore the ſpace EF will here be found by computation to be about $16\frac{1}{12}$ feet. Conſequently, if the power by which the moon is retained in its orbit be near the ſurface of the earth greater than at the diſtance of the moon in the duplicate proportion of that diſtance, the number of feet a body would deſcend near the ſurface of the earth by the action of this power upon it, in one minute, would be equal to the number $16\frac{1}{12}$ multiplied twice into the number 60; that is, to 58050. But how faſt bodies fall near the ſurface of the earth may be known by the pendulum; and by the exacteſt experiments, they

276 Her motion particularly explained.

277 Calculation of the velocity of falling bodies.

are

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are found to descend the space of 16$\frac{1}{12}$ feet in one second; and the spaces described by falling bodies being in the duplicate proportion of the times of their fall, the number of feet a body would describe in its fall near the surface of the earth in one minute of time will be equal to 16$\frac{1}{12}$ twice multiplied by 60; the same as would be caused by the power which acts upon the moon.

278 Earth and moon move about their common centre of gravity.

In this computation the earth is supposed to be at rest: but it would have been more exact to have supposed it to move, as well as the moon, about their common centre of gravity; as will easily be understood from what has been already said concerning the motion of the sun and primary planets about their common centre of gravity. The action of the sun upon the moon is also here neglected; and Sir Isaac Newton shows, if you take in both these considerations, the present computation will best agree to a somewhat greater distance of the moon and earth, viz. to 61$\frac{1}{12}$ semidiameters of the latter, which distance is more conformable to astronomical observations; and these computations afford an additional proof that the action of the earth observes the same proportion to the distance which is here contended for. In Jupiter and Saturn this power is so far from being confined to a small extent of space, that it not only reaches to several satellites at very different distances, but also from one planet to another, nay, even through the whole planetary system; consequently there is no appearance of reason why this power should not act at all distances, even at the very surfaces of these planets as well as farther off. But from hence it follows, that the power which retains the moon in her orbit is the same as that which causes bodies near the surface of the earth to gravitate: for since the power by which the earth acts on the moon will cause bodies near the surface of it to descend with all the velocity they are found to do, it is certain no other power can act upon them besides; because if it did, they must of necessity descend swifter. Now, from all this, it is at length very evident, that the power in the earth which we call *gravity* extends up to the moon, and decreases in the duplicate proportion of the increase of the distance from the earth.

279 Action of the sun upon the secondary Planets.

Thus far with respect to the action of the primary planets upon their secondaries. The next thing to be shown is, that the sun likewise acts upon them. For this purpose we must observe, that if to the motion of the satellite whereby it would be carried round its primary at rest, we superadd the same motion, both in regard to the velocity and direction, as the primary itself has, it will describe about the primary the same orbit with as great regularity as if the primary had been indeed at rest. This proceeds from the law of motion, which makes a body near the surface of the earth descend perpendicularly, though the earth be in so swift a motion, that if the falling body did not partake of it, its descent would be remarkably oblique; and that a body projected describes in the most regular manner the same parabola, whether projected in the direction in which the earth moves, or in the opposite direction, if the projecting force be the same. From this we learn, that if the satellite moved about its primary with perfect regularity, besides its motion about the primary it would have the same progressive velocity with which the primary is carried about the sun, in a direction parallel to that impulse of its primary: And, on the contrary, the want of either of these, in particular of the impulse towards the sun, will occasion great inequalities in the motion of the secondary planet. The inequalities which would arise from the absence of this impulse towards the sun are so great, that by the regularity which appears in the motion of the secondary planets, it is proved, that the sun communicates to them the same velocity by its action as it gives to their primary at the same distance. For Sir Isaac Newton informs us, that upon examination he found, that if any of the satellites of Jupiter were attracted by the sun more or less than Jupiter himself at the same distance, the orbit of that satellite, instead of being concentrical to Jupiter, would have its centre at a greater or lesser distance than the centre of Jupiter from the sun, nearly in the subduplicate proportion of the difference between the sun's action upon the satellite and upon Jupiter. Therefore, if any satellite were attracted by the sun but one hundredth part more or less than Jupiter is at the same distance, the orbit of that satellite would be distant from the centre of Jupiter no less than a fifth part of the outermost satellite from Jupiter; which is almost the whole distance of the innermost satellite. By the like argument, the satellites of Saturn gravitate towards the sun as much as Saturn itself at the same distance, and the moon as much as the earth.

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280 Secondary planets equally attracted by the sun with their primaries.

281 Whence the inequalities in the motions of the secondary planets arise.

Thus it is proved, that the sun acts upon the secondary planets as much as upon the primaries at the same distance: but it has also been shown, that the action of the sun upon bodies is reciprocally in the duplicate proportion of the distance; therefore the secondary planets being sometimes nearer to the sun than to the primary, and sometimes more remote, they are not always acted upon in the same degree with their primary, but when nearer to the sun are attracted more, and when further off are attracted less. Hence arise various inequalities in the motion of the secondary planets.

282 Inequalities of the moon's motion explained.

Some of these inequalities, however, would take place, though the moon if undisturbed by the sun had moved in a circle concentrical to the earth, and in the plane of the earth's motion; others depend on the elliptical figure and oblique situation of the moon's orbit. One of the former is, that the moon does not describe equal spaces in equal times, but is continually accelerated as she passes from the quarter to the new or full, and is retarded again by the like degrees in returning from the new and full to the next quarter: but here we consider not so much the absolute as the apparent motions of the moon with respect to us. These two may be distinguished in the following manner. Let S, in fig. 123. represent the sun, A the earth moving in its orbit BC, DEFG the moon's orbit, and H the place of the moon in her orbit. Suppose the earth to have moved from A to I. Because it has been shown that the moon partakes of all the progressive motion of the earth, and likewise that the sun attracts both the earth and moon equally when they are at the same distance from it, or that the mean action of the sun upon the moon is equal to its action upon the earth; we must therefore consider the moon as carrying about with it the moon's orbit: so that when the earth is removed from A to I, the moon's orbit shall likewise

be

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be removed from its former ſituation into that denoted by KLMN. But now the earth being in I, if the moon were found in O, ſo that OI ſhould be parallel to HA, though the moon would readily have moved from H to O, yet it would not have appeared to a ſpectator upon the earth to have moved at all, becauſe the earth has moved as much as itſelf; ſo that the moon would ſtill appear in the ſame place with reſpect to the fixed ſtars. But if the moon be obſerved in P, it will then appear to have moved, its apparent motion being meaſured by the angle under OIP. And if the angle under PIS be leſs than the angle under HAS, the moon will have approached nearer its conjunction with the ſun. Now, to explain particularly the inequality of the moon's motion already mentioned, let S, in fig. 124. repreſent the ſun, A the earth, BCDE the moon's orbit, C the place of the moon when in the latter quarter. Here it will be nearly at the ſame diſtance from the ſun as the earth is. In this caſe, therefore, they will be both equally attracted, the earth in the direction AS, and the moon in that CS. Whence, as the earth, in moving round the ſun, is continually deſcending towards it, ſo the moon in this ſituation muſt in any equal portion of time deſcend as much; and therefore the poſition of the line AC in reſpect of AS, and the change which the moon's motion produces in the angle CAS, will not be altered by the ſun; but as ſoon as the moon is advanced from the quarter toward the new or conjunction, ſuppoſe to G, the action of the ſun upon it will have a different effect. Were the ſun's action upon the moon here to be applied in the direction GH parallel to AS, if its action on the moon were equal to its action on the earth, no change would be wrought by the ſun on the apparent motion of the moon round the earth. But the moon receiving a greater impulſe in G than the earth receives in A, were the ſun to act in the direction GH, yet it would accelerate the deſcription of the ſpace DAG, and cauſe the angle under GAD to decreaſe faſter than it otherwiſe would. The ſun's action will have this effect upon account of the obliquity of its direction to that in which the earth attracts the moon. For the moon by this means is drawn by two forces oblique to one another; one drawing from G towards A, the other from G towards H; therefore the moon muſt neceſſarily be impelled toward D. Again, becauſe the ſun does not act in the direction GH parallel to SA, but in the direction GS oblique to it, the ſun's action on the moon will, by reaſon of this obliquity, farther contribute to the moon's acceleration. Suppoſe the earth, in any ſhort ſpace of time, would have moved from A to I, if not attracted by the ſun, the point I being in the ſtraight line CE, which touches the earth's orbit in A. Suppoſe the moon in the ſame time would have moved in her orbit from G to K, and beſides have partook of all the progreſſive motion of the earth. Then, if KL be drawn parallel to AI, and taken equal to it, the moon, if not attracted to the ſun, would be found in L. But the earth, by the ſun's action, is removed from I. Suppoſe it were moved down to M in the line IMN parallel to SA, and if the moon were attracted but as much, and in the ſame direction, as the earth is here ſuppoſed to be attracted, ſo as to have deſcended during the ſame time in the line LO parallel alſo to AS, down as far as P, till LP were equal to IM, the angle under PMN would be equal to that under LIN; that is, the moon will appear advanced as much farther forward than if neither it nor the earth had been ſubject to the ſun's action. But this is on the ſuppoſition that the actions of the ſun upon the earth and moon are equal; whereas the moon being acted upon more than the earth, did the ſun's action draw the moon in the line LO parallel to AS, it would draw it down ſo far as to make LP greater than IM, whereby the angle under PMN will be rendered greater than that under LIN. But, moreover, as the ſun draws the earth in a direction oblique to IN, the earth will be found in its orbit ſomewhat ſhort of the point M. However, the moon is attracted by the ſun ſtill more out of the line LO than the earth is out of the line IN; therefore this obliquity of the ſun's action will yet farther diminiſh the angle under PMN. Thus the moon at the point G receives an impulſe from the ſun whereby her motion is accelerated; and the ſun producing this effect in every place between the quarter and the conjunction, the moon will move from the quarter with a motion continually more and more accelerated; and therefore, by acquiring from time to time an additional degree of velocity in its orbit, the ſpaces which are deſcribed in equal times by the line drawn from the earth to the moon will not be every where equal, but thoſe toward the conjunction will be greater than thoſe towards the quarter. But in the moon's paſſage from the conjunction D to the next quarter, the ſun's action will again retard the moon, till, at the next quarter at E, it be reſtored to the firſt velocity which it had in C. When the moon moves from E to the full, or oppoſition to the ſun in B, it is again accelerated; the deficiency of the ſun's action on the moon from what it has upon the earth producing here the ſame effect as before the exceſs of its action.

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Let us now conſider the moon in Q as moving from E towards B. Here, if ſhe were attracted by the ſun in a direction parallel to AS, yet being acted on leſs than the earth, as the latter deſcends towards the ſun, the moon will in ſome meaſure be left behind. Therefore, QF being drawn parallel to SB, a ſpectator on the earth would ſee the moon move as if attracted from the point Q in the direction QF, with a degree of force equal to that whereby the ſun's action on the moon falls ſhort of its action on the earth. But the obliquity of the ſun's action has here alſo an effect. In the time the earth would have moved from A to I without the influence of the ſun, let the moon have moved in its orbit from Q to R. Drawing, therefore, RT parallel and equal to AI, the moon, by the motion of its orbit, if not attracted by the ſun, muſt be found in T; and therefore, if attracted in a direction parallel to SA, would be in the line TV parallel to AS; ſuppoſe in W. But the moon in Q being farther off the ſun than the earth, it will be leſs attracted; that is, TW will be leſs than IM; and if the line SM be prolonged towards X, the angle under XMW will be leſs than XIT. Thus, by the ſun's action, the moon's paſſage from the quarter to the full would be accelerated, if the ſun were to act on the earth and moon in a direction parallel to AS: and the obliquity of the ſun's action will ſtill increaſe this acceleration:

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For the action of the sun on the moon is oblique to the line SA the whole time of the moon's passage from Q to T, and will carry her out of the line TV towards the earth. Here we suppose the time of the moon's passage from Q to T so short, that it shall not pass beyond the line SA. The earth will also come a little short of the line IN, as was already mentioned; and from these causes the angle under XMW will be still farther lessened. The moon, in passing from the opposition B to the next quarter, will be retarded again by the same degrees as it was accelerated before its appulse to the opposition; and thus the moon, by the sun's action upon it, is twice accelerated and twice restored to its first velocity every circuit it makes round the earth; and this inequality of the moon's motion about the earth is called by astronomers its variation.

283 Effect of the sun's attraction in different parts of the moon's orbit.

The next effect of the sun upon the moon is, that it gives the orbit of the latter in the quarters a greater degree of curvature than it would receive from the earth alone; and, on the contrary, in the conjunction and opposition the orbit is less inflected. When the moon is in the conjunction with the sun at D, the latter attracting her more forcibly than it does the earth, the moon is by that means impelled less to the earth than otherwise it would be, and thus the orbit less incurvated: for the power by which the moon is impelled towards the earth being that by which it is inflected from a rectilinear course, the less that power is the less it will be inflected. Again, when the moon is in the opposition in B farther removed from the sun than the earth is, it follows then, that though the earth and moon are both continually descending toward the sun, that is, are drawn by the sun towards itself out of the place they would otherwise move into, yet the moon descends with less velocity than the earth; insomuch that, in any given space of time from its passing the point of opposition, it will have less approached the earth than otherwise it would have done; that is, its orbit, in respect to the earth, will approach nearer to a straight line. Lastly, when the moon is in the quarter in F, and equally distant from the sun as the earth, it was before observed, that they would both descend with equal velocity towards the sun, so as to make no change in the angle FAS; but the length of the line FA must necessarily be shortened. Therefore the moon, in moving from F toward the conjunction with the sun, will be impelled more toward the earth by the sun's action than it would have been by the earth alone, if neither the earth nor the moon had been acted upon by the sun; so that, by this additional impulse, the orbit is rendered more curve than it otherwise should be. The same effect will also be produced in the other quarter.

A third effect of the sun's action, and which follows from that just now explained, is, that though the moon undisturbed by the sun might move in a circle, having the earth for its centre, by the sun's action, if the earth were to be in the very middle or centre of the moon's orbit, yet the moon would be nearer the earth at the new and full than in the quarters. This

284 Moon comes nearest the earth when least attracted by it.

may at first appear somewhat difficult to be understood, that the moon should come nearest to the earth where it is least attracted by it: yet, upon a little consideration, it will evidently appear to flow from that very cause, because her orbit, in the conjunction and opposition, is rendered less curve; for the less curve the orbit is, the less will the moon have descended from the place it would move into without the action of the earth. Now, if the moon were to move from any place without farther disturbance from that action, since it would proceed on the line touching the orbit in that place, it would continually recede from the earth; and therefore, if the power of the earth upon the moon be sufficient to retain it at the same distance, this diminution of that power will cause the distance to increase, though in a less degree. But, on the other hand, in the quarters, the moon being pressed in a less degree towards the earth than by the earth's single action, will be made to approach it: so that, in passing from the conjunction or opposition to the quarters, the moon ascends from the earth; and in passing from the quarters to the opposition or conjunction, it descends again, becoming nearer in these last mentioned places than in the other.

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All the inequalities we have mentioned are different in degree as the sun is more or less distant from the earth; being greatest when the earth is in its perihelion, and smallest when it is in its aphelion: for in the quarters, the nearer the moon is to the sun the greater is the addition to the earth's action upon it by the power of the sun; and in the conjunction and opposition the difference between the sun's action upon the earth and upon the moon is likewise so much the greater. This difference in the distance between the earth and the sun produces a farther effect upon the moon's motion; causing her orbit to dilate when less remote from the sun, and become greater than when at a farther distance: For it is proved by Sir Isaac Newton, that the action of the sun by which it diminishes the earth's power over the moon in the conjunction or opposition, is about twice as great as the addition to the earth's action by the sun in the quarters; so that, upon the whole, the power of the earth on the moon is diminished by the sun, and therefore is most diminished when that action is strongest: but as the earth, by its approach to the sun, has its influence lessened, the moon, being less attracted, will gradually recede from the earth; and as the earth, in its recess from the sun, recovers by degrees its former power, the orbit of the moon must again contract. Two consequences follow from hence, viz. that the moon will be more remote from the earth when the latter is nearest the sun, and also will take up a longer time in performing its revolution through the dilated orbit than through the more contracted.

285 Cause of the dilatation of the moon's orbit.

These irregularities would be produced if the moon, without being acted upon unequally by the sun, should describe a perfect circle about the earth and in the plane of its motion; but though neither of these circumstances take place, yet the abovementioned inequalities occur only with some little variation with regard to the degree of them; but some others are observed to take place from the moon's motion being performed in the manner already described: For, as the moon describes an ellipsis, having the earth in one of its foci, this curve will be subjected to various changes, neither preserving constantly the same figure nor position; and because the plane of this ellipsis is not the same with that of the earth's orbit, it thence follows, that the former will continually change; so

ASTRONOMY

Plate LXXIV

Fig. 147

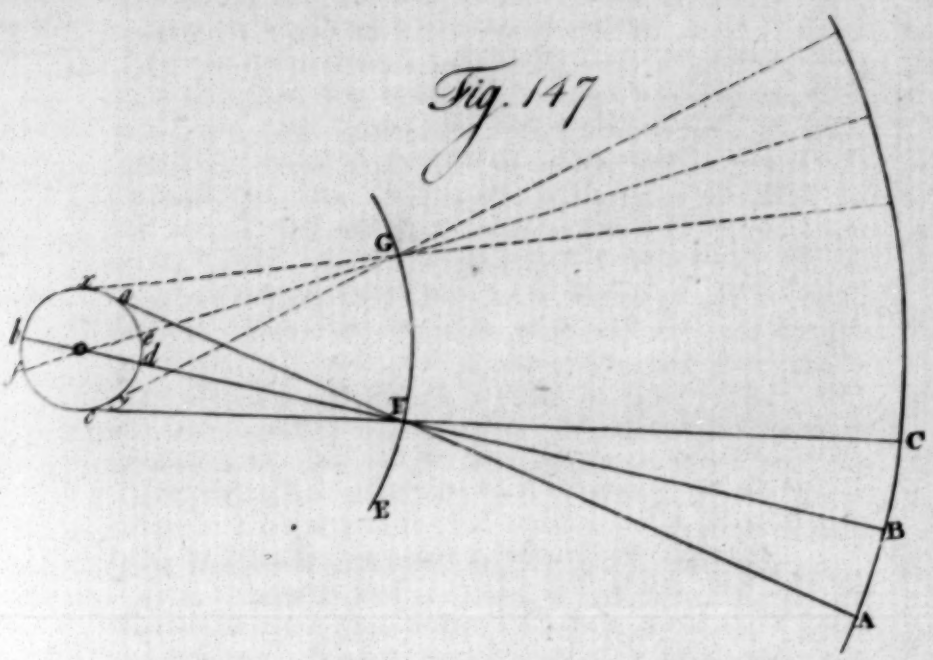


Fig. 149

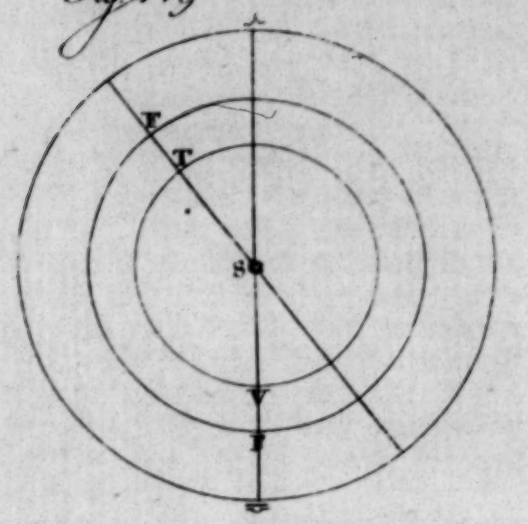


Fig. 148

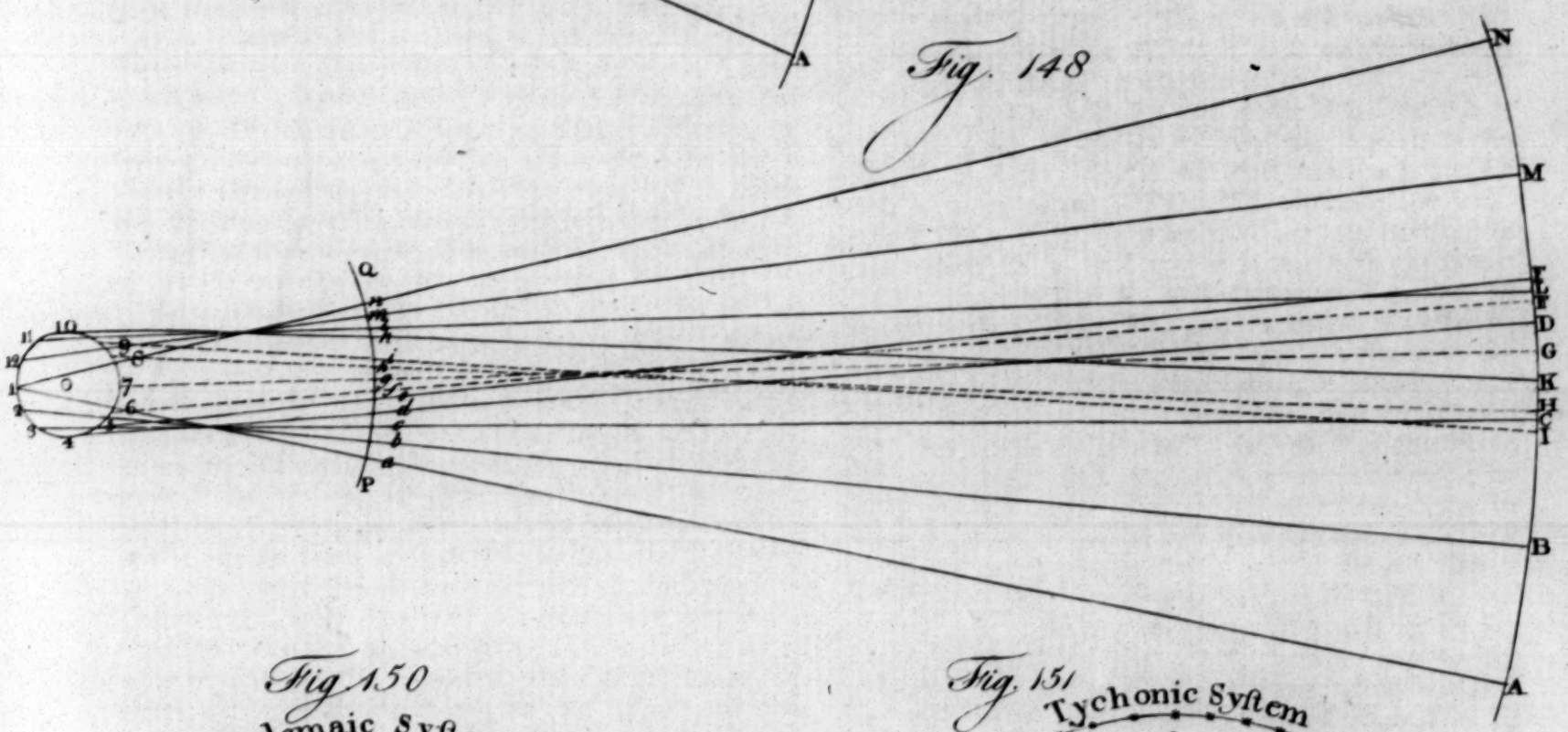


Fig. 150

Ptolemaic System

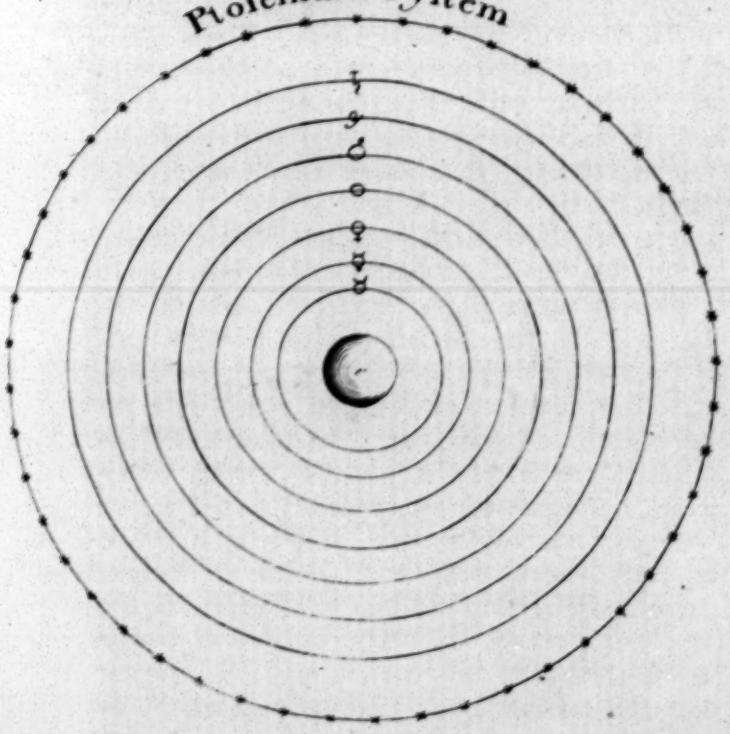
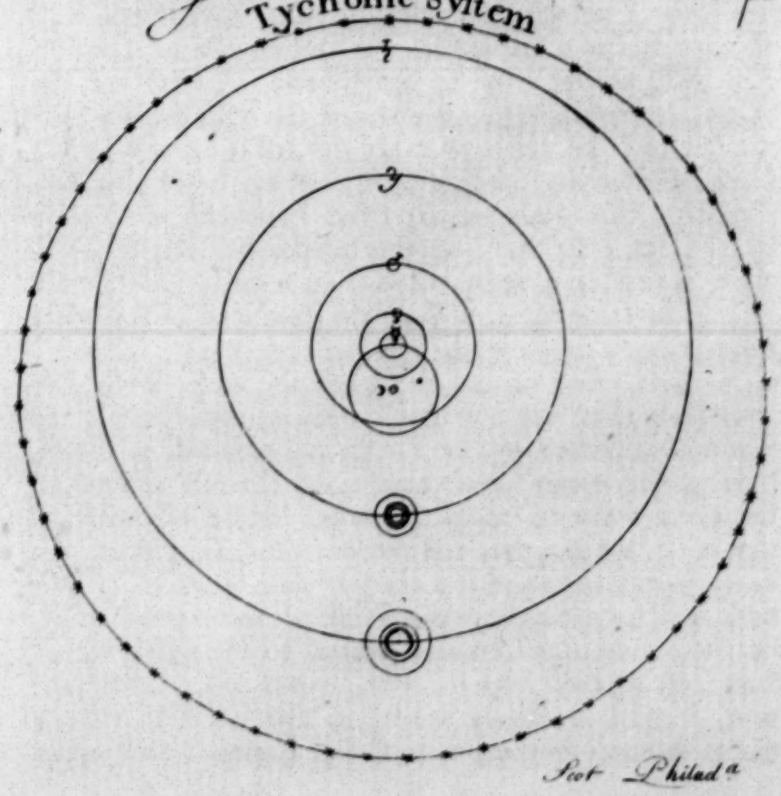


Fig. 151

Tychonic System



Scot Philad.a

Motions of the Secondary Planets.

that neither the inclination of the two planes towards each other, nor the line in which they interſect, will remain for any length of time unaltered.

286 Action of the ſun cauſes the plane of the moon's orbit to change.

As the moon does not move in the ſame plane with the earth, the ſun is but ſeldom in the plane of her orbit, viz. only when the line made by the common interſection of the two planes, if produced, will paſs through the ſun. Thus, let S, in fig. 125. denote the ſun, T the earth, ATB the plane of the earth's orbit, CDEF the moon's orbit; the part CDE being raiſed above, and the part CFE depreſſed under the former. Here the line CE, in which the two planes interſect each other, being continued, paſſes through the ſun in S. When this happens, the action of the ſun is directed in the plane of the moon's orbit, and cannot draw her out of this plane, as will evidently appear from an inſpection of the figure; but in other caſes the obliquity of the ſun's action to the plane of the orbit will cauſe this plane continually to change.

Let us now ſuppoſe, in the firſt place, the line in which the two planes interſect each other to be perpendicular to the line which joins the earth and ſun. Let T, in fig. 126, 127, 128, 129. repreſent the earth; S the ſun; the plane of the ſcheme the plane of the earth's orbit, in which both the ſun and earth are placed. Let AC be perpendicular to ST, which joins the earth and ſun; and let the line AC be that in which the plane of the moon's orbit interſects the orbit of the earth. On the centre T deſcribe in the plane of the earth's motion the circle ABCD; and in the plane of the moon's orbit deſcribe the circle AECF; one-half of which, AEC, will be elevated above the plane of this ſcheme, and the other half, AFC, as much depreſſed below it. Suppoſe then the moon to ſet out from the point A, in fig. 127. in the direction of the plane AEC. Here ſhe will be continually drawn out of this plane by the action of the ſun; for this plane AEC, if extended, will not paſs through the ſun, but above it; ſo that the ſun, by drawing the moon directly toward itſelf, will force it continually more and more from that plane towards the plane of the earth's motion in which itſelf is, cauſing it to deſcribe the line AKGHI, which will be convex to the plane AEC and concave to the plane of the earth's motion. But here this power of the ſun, which is ſaid to draw the moon toward the plane of the earth's motion, muſt be underſtood principally of as much only of the ſun's action upon the moon as it exceeds the action of the ſame upon the earth: For ſuppoſe the laſt mentioned figure to be viewed by the eye placed in the plane of that ſcheme; and in the line CTA, on the ſide A, will appear as the ſtraight line TDB in fig. 130. and the plane AECF as another ſtraight line FE, and the curve line AKGHI under the form of the line TKGHI. Now it is plain, that the earth and moon being both attracted by the ſun, if the ſun's action upon both was equally ſtrong, the earth T, and with it the plane AECF, or the line FTE, would be carried towards the ſun with as great velocity as the moon, and therefore the moon not drawn out of it by the ſun's action, except only from the ſmall obliquity of direction of this action upon the moon to that of the ſun's action upon the earth, which ariſes from the moon being out of the plane of the earth's motion, and is not conſiderable; but the action of the ſun upon the moon being greater than upon the earth all the time the moon is nearer to the ſun than the earth is, it will be drawn from the plane AEC, or the line TE, by that exceſs, and made to deſcribe the curve line AGI or TGI. But it is the cuſtom of aſtronomers, inſtead of conſidering the moon as moving in ſuch a curve line, to refer its motion continually to the plane which touches the true line wherein it moves at the point where at any time the moon is. Thus, when the moon is in the point A, its motion is conſidered as being in the plane AEC, in whoſe direction it then attempts to move; and when in the point K, fig. 127. its motion is referred to the plane which paſſes through the earth and touches the line AKGHI in the point K. Thus the moon, in paſſing from A to I, will continually change the plane of her motion in the manner we ſhall now more particularly explain.

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Let the plane which touches the line AKI in the point K, fig. 127. interſect the plane of the earth's orbit in the line LTM. Then, becauſe the line AKI is concave to the plane ABC, it falls wholly between that plane and the plane which touches it in K; ſo that the plane MKL will cut the plane AEC before it meets the plane of the earth's motion, ſuppoſe in the line YT, and the point A will fall between K and L. With a radius equal to TY or TL deſcribe the ſemicircle LYM. Now, to a ſpectator on the earth, the moon when in A will appear to move in the circle AECF; and when in K, will appear to be moving in the ſemicircle LYM. The earth's motion is performed in the plane of this ſcheme; and to a ſpectator on the earth the ſun will always appear to move in that plane. We may therefore refer the apparent motion of the ſun to the circle ABCD deſcribed in this plane about the earth. But the points where this circle in which the ſun ſeems to move interſects the circle in which the moon is ſeen at any time to move, are called the nodes of the moon's orbit at that time. When the moon is ſeen moving in the circle AECD, the points A and C are the nodes of the orbit; when ſhe appears in the ſemicircle LYM, then L and M are the nodes. It will now appear, from what has been ſaid, that while the moon has moved from A to K, one of the nodes has been carried from A to L, and the other as much from C to M. But the motion from A to L and from C to M is backward in regard to the motion of the moon, which is the other way from A to K, and from thence toward C. Again, the angle which the plane wherein the moon at any time appears makes with the plane of the earth's motion, is called the inclination of the moon's orbit at that time: we ſhall now therefore proceed to ſhow, that this inclination of the orbit, when the moon is in K, is leſs than when ſhe was in A; or, that the plane LYM, which touches the line of the moon's motion in K, makes a leſs angle with the plane of the earth's motion, or with the circle ABCD, than the plane AEC makes with the ſame. The ſemicircle LYM interſects the ſemicircle AEC in Y, and the arch AY is leſs than LY, and both together leſs than half a circle. But it is demonſtrated by ſpheric geometry, that when a triangle is made as here, by three arches of circles AL, AY, and YL, the angle under YAB without the triangle is greater than the angle YLA within, if the two arches AY, YL, taken toge-

287 Nodes of the moon's orbit.

288 Inclination of her orbit.

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ther, do not amount to a ſemicircle. If the two arches make a complete ſemicircle, the two angles will be equal; but if the two arches taken together exceed a ſemicircle, the inner angle YLA is greater than the other. Here then the two arches AY and LY together being leſs than a ſemicircle, the angle under ALY is leſs than the angle under BAE. But from the doctrine of the ſphere it is alſo evident, that the angle under ALY is equal to that in which the plane of the circle LYKM, that is, the plane which touches the line AKGHI in K is inclined to the plane of the earth's motion ABC; and the angle under BAE is equal to that in which the plane AEC is inclined to the ſame plane. Therefore the inclination of the former plane is leſs than that of the latter. Suppoſe, now, the moon to be advanced to the point G in fig. 128. and in this point to be diſtant from its node a quarter part of the whole circle; or, in other words, to be in the mid-way between its two nodes. In this caſe the nodes will have receded yet more, and the inclination of the orbit be ſtill more diminiſhed: for ſuppoſe the line AKGHI to be touched in the point G by a plane paſſing through the earth T, let the interſection of this plane with the plane of the earth's motion be the line WTO, and the line TP its interſection with the plane LKM. In this plane let the circle NGO be deſcribed with the ſemidiameter TP or NT cutting the other circle LKM in P. Now, the line AKGI is convex to the plane LKM which touches it in K; and therefore the plane NGO, which touches it in G, will interſect the other touching plane between G and K; that is, the point P will fall between theſe two points, and the plane continued to the plane of the earth's motion will paſs beyond L; ſo that the points N and O, or the places of the nodes when the moon is in G, will be farther from A and C than L and M; that is, will have moved farther backward. Beſides, the inclination of the plane NGO to the plane of the earth's motion ABC is leſs than the inclination of the plane LKM to the ſame; for here alſo the two arches LP and NP, taken together, are leſs than a ſemicircle, each of them being leſs than a quadrant, as appears, becauſe GN, the diſtance of the moon in G from its node N, is here ſuppoſed to be a quarter part of a circle. After the moon is paſſed beyond G, the caſe is altered: for then theſe arches will be greater than quarters of a circle; by which means the inclination will be again increaſed, though the nodes ſtill go on to move the ſame way. Suppoſe the moon in H (fig. 129), and that the plane which touches the lines AKGI in H interſects the plane of the earth's motion in the line QTR, and the plane NGO in the line TV, and beſides, that the circle QHR be deſcribed in that plane: then, for the ſame reaſon as before, the point V will fall between H and G, and the plane RVQ will paſs beyond the laſt plane OVN, cauſing the points Q and K to fall farther from A and C than N and O. But the arches NV, VQ are each greater than the quarter of a circle; conſequently the angle under BQV will be greater than that under BNV. Laſtly, when the moon is by this attraction of the ſun drawn at length into the plane of the earth's orbit, the node will have receded yet more, and the inclination be ſo much increaſed, as to become ſomewhat more than at firſt: for the line AKGHI being convex to all the planes which touch it, the part HI will wholly fall between the plane QVR and the plane ABC; ſo that the point I will fall between B and R; and, drawing ITW, the point W, will be farther removed from A than Q. But it is evident, that the plane which paſſes through the earth T and touches the line AGI in the point I, will cut the plane of the earth's motion ABCD in the line ITW, and be inclined to the ſame in the angle under HIB; ſo that the node which was firſt in A, after having paſſed into L, N, and Q, comes at laſt into the point W, as the node which was at firſt in C has paſſed from thence ſucceſſively through the points M, O, and R, to I. But the angle HIB, which is now the inclination of the orbit to the plane of the ecliptic, is manifeſtly not leſs than the angle under ECB or EAB, but rather ſomething greater. Thus the moon, while it paſſes from the plane of the earth's motion in the quarter, till it comes again into the ſame plane, has the nodes of its orbit continually moved backward, and the inclination of it at firſt diminiſhed till it comes to G in fig. 128, which is near to its conjunction with the ſun, but afterwards is increaſed again almoſt by the ſame degrees, till upon the moon's arrival again to the plane of the earth's motion the inclination of the orbit is reſtored to ſomething more than its firſt magnitude, though the difference is not very great, becauſe the points I and C are not ſo far diſtant from each other.

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In like manner, if the moon had departed from the quarter at C, it ſhould have deſcribed the curve line CXW in fig. 126. between the planes AFC and ADC, which would be convex to the former planes and concave to the latter; ſo that here alſo the nodes would continually recede, and the inclination of the orbit gradually diminiſh more and more, till the moon arrived near its oppoſition to the ſun in X; but from that time the inclination ſhould again increaſe till it become a little greater than at firſt. This will eaſily appear by conſidering, that as the action of the ſun upon the moon, by exceeding its action upon the earth, drew it out of the plane AEC towards the ſun, while the moon paſſed from A to I; ſo during its paſſage from C to W, the moon being all that time farther from the ſun than the earth, it will be attracted leſs; and the earth together with the plane AECF, will as it were be drawn from the moon, in ſuch a manner, that the path the moon deſcribes ſhall appear from the earth as it did in the former caſe by the moon being drawn away.

286 Motion of the nodes explained.

Such are the changes which the nodes and inclination of the moon's orbit undergo when the nodes are in the quarters; but when the nodes by their motion, and the motion of the ſun together, come to be ſituated between the quarter and conjunction or oppoſition, their motion and the change made in the inclination of the orbit are ſomewhat different.—Let AGH, in fig. 131. be a circle deſcribed in the plane of the earth's motion, having the earth in T for its centre, A the point oppoſite to the ſun, and G a fourth part of the circle diſtant from A. Let the nodes of the moon's orbit be ſituated in the line BTD, and B the node falling between A, the place where the moon would be in the full, and G the place where ſhe would be in the quarter. Suppoſe BEDF to be the plane in which the moon attempts to move when it proceeds from the point B; then, becauſe the moon in B is more

diſtant

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distant from the ſun than the earth, it will be leſs attracted by the ſun, and will not deſcend towards the ſun ſo faſt as the earth, conſequently it will quit the plane BEDF, which is ſuppoſed to accompany the earth, and deſcribe the line BIK convex to it, till ſuch time as it comes to the point K, where it will be in the quarter; but from thenceforth being more attracted than the earth, the moon will change its courſe, and the following part of the path it deſcribes will be concave towards the plane BED or BGD, and continue concave to the plane BGD till it croſſes that plane in L, juſt as in the preceding caſe. Now, to ſhow that the nodes, while the moon is paſſing from B to K, will proceed forward, or move the ſame way with the moon, and at the ſame time the inclination of the orbit will increaſe when the moon is in the point I, let the line MIN paſs through the earth T, and touch the path of the moon in I, cutting the plane of the earth's motion in the line MTN, and the line BED in TO. Becauſe the line BIK is convex to the plane BED, which touches it in B, the plane NIM muſt croſs the plane DEB before it meets the plane CGB; and therefore the point M will fall from G towards B; and the node of the moon's orbit being tranſlated from B towards M is moved forward.

Again, the angle under OMG, which the plane MON makes with the plane BGC, is greater than the angle OBG, which the plane BOD makes with the ſame. This appears from what has been already demonſtrated, becauſe the arches BO and OM are each of them leſs than the quarter of a circle; and therefore, taken both together are leſs than a ſemicircle. But further, when the moon is come to the point K in its quarter, the nodes will be advanced yet further forward, and the inclination of the orbit alſo more augmented. Hitherto we have referred the moon's motion to the plane which, paſſing through the earth, touches the path of the moon in the point where the moon is, as we have already ſaid that the cuſtom of aſtronomers is. But in the point K no ſuch plane can be found: on the contrary, ſeeing the line of the moon's motion on one ſide the point K is convex to the plane BED, and on the other ſide concave to the ſame, ſo that no plane can paſs through the points T and K, but will cut the line BKL in that point; therefore, inſtead of ſuch a touching plane, we muſt make uſe of PKQ, which is equivalent, and with which the line BKL ſhall make a leſs angle than with any other plane; for this does as it were touch the line BK in the point K, ſince it cuts it in ſuch a manner that no other plane can be drawn ſo as to paſs between the line BK and the plane PKQ. But now it is evident, that the point P, or the node, is removed from M towards G, that is, has moved yet farther forwards; and it is likewiſe as manifeſt, that the angle under KPG, or the inclination of the moon's orbit in the point K, is greater than the angle under IMG for the reaſon already given.

After the moon has paſſed the quarter, her plane being concave to the plane AGCH, the nodes will recede as before till ſhe arrives at the point L; which ſhows, that, conſidering the whole time of the moon's paſſing from B to L, at the end of that time the nodes ſhall be found to have receded, or to be placed more backward, when the moon is in L than when it was in B: for the moon takes a longer time in paſſing from K to L than in paſſing from B to K; and therefore the nodes continue to recede a longer time than they moved forwards; ſo that their receſs muſt ſurmount their advance. In the ſame manner, while the moon is in its paſſage from K to L, the inclination of the orbit ſhall diminiſh till the moon come to the point in which it is one quarter part of a circle diſtant from its node, ſuppoſe in the point R; and from that time the inclination will again increaſe. Since, therefore, the inclination of the orbit increaſes while the moon is paſſing from B to K, and diminiſhes itſelf again only while the moon is paſſing from K to R, then augments again while the moon paſſes from B to L; it thence comes to be much more increaſed than diminiſhed, and thus will be diſtinguiſhably greater, when the moon comes to L than when it ſets out from B. In like manner, when the moon is paſſing from L on the other ſide the plane AGCH, the node will advance forward as long as the moon is between the point L and the next quarter; but afterwards it will recede till the moon comes to paſs the plane AGCH again, in the point V between B and A: and becauſe the time between the moon's paſſing from L to the next quarter is leſs than the time between that quarter and the moon's coming to the point V, the node will have receded more than it has advanced; ſo that the point V will be nearer to A than L is to C. So alſo the incination of the orbit, when the moon is in V, will be greater than when ſhe was in L: for this inclination increaſes all the time the moon is betwixt L and the next quarter, decreaſing only when ſhe is paſſing from this quarter to the mid-way between the two nodes, and from thence increaſes again during the whole paſſage through the other half of the way to the next node.

In this manner we ſee, that at every period of the moon the nodes will have receded, and thereby have approached towards a conjunction with the ſun; but this will be much forwarded by the motion of the earth, or the apparent motion of the ſun himſelf. In the laſt ſcheme the ſun will appear to have moved from S towards W. Let us ſuppoſe it had appeared to have moved from S to W while the moon's node has receded from B to V: then drawing the line WTX, the arch VX will repreſent the diſtance of the line drawn between the nodes from the ſun when the moon is in V; whereas the arch BA repreſented that diſtance when the moon was in B. This viſible motion of the ſun is much greater than that of the node; for the ſun appears to revolve quite round in one year, while the node is near nineteen in making its revolution. We have alſo ſeen, that when the moon was in the quadrature, the inclination of her orbit decreaſed till ſhe came to the conjunction or oppoſition, according to the node it ſet out from; but that afterwards it again increaſed till it became at the next node rather greater than at the former. When the node is once removed from the quarter nearer to a conjunction with the ſun, the inclination of the moon's orbit when ſhe comes into the node is more ſenſibly greater than it was in the node preceding; the inclination of the orbit by this means more and more increaſing till the node comes into conjunction with the ſun: at which time it has been ſhown that the latter has no power to

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change the plane of her orbit. As ſoon, however, as the nodes are got out of conjunction towards the other quarters, they begin to recede as before; but the inclination of the orbit in the appulſe of the moon to each ſucceeding node is leſs than at the preceding, till the nodes come again into the quarters. This will appears as follows: Let A, in fig. 132. repreſent one of the moon's nodes placed between the point of oppoſition B and the quarter C. Let the plane ADE paſs through the earth T, and touch the path of the moon in A. Let the line AFGH be the path of the moon in her paſſage from A to H, where ſhe croſſes again the plane of the earth's motion. This line will be convex towards the plane ADE, till the moon comes to G, where ſhe is in the quarter; and after this, between G and H, the ſame line will be concave towards this plane. All the time this line is convex towards the plane ADE, the nodes will recede; and, on the contrary, move forward when the line is concave towards that plane. But the moon is longer in paſſing from A to G, and therefore the nodes go backward farther than they proceed; and therefore, on the whole, when the moon has arrived at H, the nodes will have receded, that is, the point H will fall between B and E. The inclination of the orbit will decreaſe till the moon is arrived at the point F in the middle between A and H. Through the paſſage between F and G the inclination will increaſe, but decreaſe again in the remaining part of the paſſage from G to H, and conſequently at H muſt be leſs than at A. Similar effects, both with reſpect to the nodes and inclination of the orbit, will take place in the following paſſage of the moon on the other ſide of the plane ABEC from H, till it comes over that plane again in I.

Thus the inclination of the orbit is greateſt when the line drawn between the moon's nodes will paſs through the ſun, and leaſt when this line lies in the quarters; eſpecially if the moon at the ſame time be in conjunction with the ſun, or in the oppoſition. In the firſt of theſe caſes the nodes have no motion; in all others, the nodes will each month have receded: and this retrograde motion will be greateſt when the nodes are in the quarters, for in that caſe they will have no progreſſive motion during the whole month; but in all other caſes they at ſome times go forward, viz. whenever the moon is between either of the quarters and the node which is leſs diſtant from that quarter than the fourth part of a circle.

290 Irregularities ariſing from the moon's motion in an ellipſis.

We have now only to explain thoſe irregularities of the lunar motion which ariſe from her motion in an ellipſis. From what has been already ſaid it appears, that the earth acts on the moon in the reciprocal duplicate proportion of the diſtance; therefore the moon, if undiſturbed by the ſun, would move round the earth in a true ellipſis, and a line drawn from the earth to the ſun would paſs over equal ſpaces in equal times. We have, however, already ſhown, that this equality is diſturbed by the ſun, and likewiſe how the figure of the orbit is changed each month; that the moon is nearer the earth at the new and full, and more remote in the quarters, than it would be without the ſun. We muſt, however, paſs by thoſe monthly changes, and conſider the effect which the ſun will have in the different ſituations of the axis of the orbit in reſpect of that luminary. This action varies the force wherewith the moon is drawn towards the earth. In the quarters the force of the earth is directly increaſed by the ſun, but diminiſhed at the new and full; and in the intermediate places the influence of the earth is ſometimes leſſened, ſometimes aſſiſted, by the action of that luminary. In theſe intermediate places, however, between the quarters and the conjunction or oppoſition, the ſun's action is ſo oblique to that of the earth on the moon, as to produce that alternate acceleration and retardation of her motion ſo oftened mentioned. But beſides this effect, the power by which the moon attracts the earth towards itſelf, will not be at full liberty to act with the ſame force as if the ſun acted not at all on the moon; and this effect of the ſun's action, whereby it corroborates or weakens the action of the earth, is here only to be conſidered; and by means of this influence it comes to paſs, that the power by which the moon is impelled towards the earth is not perfectly in the reciprocal duplicate proportion of the diſtance, and of conſequence the moon will not deſcribe a perfect ellipſis. One particular in which the lunar orbit will differ from a perfect elliptical figure, conſiſts in the places where the motion of the moon is perpendicular to the line drawn from itſelf to the earth. In an ellipſis, after the moon ſhould have ſet out in the direction perpendicular to this line, drawn from itſelf to the earth, and at its greateſt diſtance from the earth, its motion would again become perpendicular to this line drawn between itſelf and the earth, and the moon be at its neareſt diſtance from the earth, when it ſhould have performed half its period; after having performed the other half period of its motion, would again become perpendicular to the forementioned line, and the moon return to the place whence it ſet out, and have recovered again its greateſt diſtance. But the moon in its real motion, after ſetting out as before, ſometimes makes more than half a revolution before its motion comes again to be perpendicular to the line drawn from itſelf to the earth, and the moon is at its neareſt diſtance; and then performs more than another half of an entire revolution before its motion can a ſecond time recover its perpendicular direction to the line drawn from the moon to the earth, and the former arrive again at its greateſt diſtance from the earth. At other times the moon will deſcend to her neareſt diſtance before ſhe has made half a revolution, and recover again its greateſt diſtance before it has made an entire revolution. The place where the moon is at its greateſt diſtance is called the *moon's apogeon*, and the place of her neareſt diſtance her *perigeon*; and this change of place, where the moon comes ſucceſſively to its greateſt diſtance from the earth, is called the *motion of the apogeon*. The manner in which this motion of the apogeon is cauſed by the ſun comes now to be explained.

291 Apogeon and perigeon of the moon.

Sir Iſaac Newton has ſhown, that if the moon were attracted toward the earth by a compoſition of two powers, one of which were reciprocally in the duplicate proportion of the diſtance from the earth, and the other reciprocally in the triplicate proportion of the ſame diſtance; then, though the line deſcribed by the moon would not be in reality an ellipſis, yet the moon's motion might be perfectly explained by an ellipſis whoſe axis ſhould be made to move round the earth; this motion being in conſequence, as aſtronomers expreſs themſelves, that is, the ſame way as the moon itſelf moves,

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moves, if the moon be attracted by the sum of the two powers; but the axis must move in antecedence, or the contrary way, if the moon be acted upon by the difference of these forces. We have already explained what is meant by duplicate proportion, namely, that if three magnitudes, as A, B, and C, are so related that the second B bears the same proportion to the third C as the first A bears to the second B; then the proportion of the first A to the third C is the duplicate of the proportion of the first A to the second B. Now if a fourth magnitude as D be assumed, to which C shall bear the same proportion as A bears to B, and B to C; then the proportion of A to D is the triplicate of the proportion of A to B.

292 Motion in antecedence and consequence explained.

293 Triplicate proportion explained.

294 Motion of the moon's apogeon determined.

Let now T (fig. 133. 134.) denote the earth, and suppose the moon in the point A its apogeon or greatest distance from the earth, moving in the direction AF perpendicular to AB, and acted upon from the earth by two such forces as already mentioned. By that power alone, which is reciprocally in the duplicate proportion of the distance, if the moon set out with a proper degree of velocity, the ellipsis AMB may be described: but if the moon be acted upon by the sum of the forementioned powers, and her velocity in the point A be augmented in a certain proportion; or if that velocity be diminished in a certain proportion *, and the moon be acted upon by the difference of those powers; in both these cases the line AE, which shall be described by the moon, shall thus be determined. Let the point M be that into which the moon would have arrived in any given point of time, had it moved in the ellipsis AMB; draw MT and likewise CTD in such a manner that the angle ATM shall bear the same proportion to the angle under ATC as the velocity with which the ellipsis must have been described bears to the difference between this velocity and that with which the moon must set out from the point A, in order to describe the path AE. Let the angle ATC be taken toward the moon, as in fig. 133. if the moon be attracted by the sum of the powers; but the contrary way (as in fig. 134.) if by their difference. Then let the line AB be moved into the position CD, and the ellipsis AMB into the situation CND, so that the point M be translated to L; then the point L shall fall upon the path of the moon AE. Now the angular motion of the line AT, whereby it is removed into the situation CT, represents the motion of the apogeon; by the means of which the motion of the moon might be fully explained by the ellipsis AMB, if the action of the sun upon it was directed to the centre of the earth, and reciprocally in the triplicate proportion of the moon's distance from it; but that not being so, the motion of the apogeon will not proceed in the regular manner now described. It is, however, to be observed here, that in the first of the two preceding cases, where the apogeon moves forward, the whole centripetal power increases faster, with the decrease of distance, than if the entire power were reciprocally in the duplicate proportion of the distance; because one part only is already in that proportion, and the other part, which is added to this to make up the whole power, increases faster with the decrease of distance. On the other hand, when the centripetal power is the difference between these two bodies, it increases less with the decrease of the distance, than if it were simply in the reciprocal duplicate proportion of the distance. Therefore, if we choose to explain the moon's motion by an ellipsis, which may be done without any sensible error, we may collect in general, that when the power by which the moon is attracted to the earth, by varying the distance, increases in a greater than the duplicate proportion of the distance diminished, a motion in consequence must be ascribed to the apogeon; but that when the attraction increases in a smaller proportion than that just mentioned, the apogeon must have given to it a motion in antecedence. It is then observed by Sir Isaac Newton, that the former of these cases obtains when the moon is in the conjunction and opposition, and the latter when she is in the quarters; so that in the former the apogeon moves according to the order of the signs; in the other, the contrary way. But, as has been already mentioned, the disturbance given to the action of the earth by the sun in the conjunction and opposition, being near twice as great as in the quarters, the apogeon will advance with a greater velocity than recede, and in the compass of a whole revolution of the moon will be carried in consequence.

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* See *Newton's Principia*, book i. prop. 44. corol. 2.

295 Inequality of the motion of the apogeon.

Sir Isaac shows, in the next place, that when the line AB coincides with the line that joins the sun and earth, the progressive motion of the apogeon, when the moon is in conjunction or opposition, exceeds the retrograde, in the quadratures, more than in any other situation of the line AB. On the contrary, when the line AB makes right angles with that which joins the earth and sun, the retrograde motion will be more considerable, nay, is found so great as to exceed the progressive; so that in this case the apogeon, in the compass of an entire revolution of the moon, is carried in antecedence. Yet from the considerations already mentioned, the progressive motion exceeds the other; so that on the whole, the motion of the apogeon is in consequence. The line AB also changes its situation with that which joins the earth and sun by such slow degrees, that the inequalities of the motion of the apogeon, arising from this last consideration, are much greater than what arise from the other.

296 Occasions another inequality in the eccentricity of the moon's orbit.

This unsteady motion of the apogeon gives rise to another inequality in the motion of the moon herself, so that it cannot at all times be explained by the same ellipsis. For whenever the apogeon moves in consequence, the motion of the luminary must be referred to an orbit more eccentric than what the moon would describe, if the whole power by which the moon was acted upon in its passing from the apogeon changed according to the reciprocal duplicate proportion of its distance from the earth, and by that means the moon did describe an immoveable ellipsis: and when the apogeon moves in antecedence, the moon's motion must be referred to an orbit less eccentric. In the former of the two figures last referred to, the true place of the moon L falls without the orbit AMB, to which its motion is referred: whence the orbit ALE truly described by the moon, is less incurvated in the point A than is the orbit AMB; therefore this orbit is more oblong, and differs farther from a circle than the ellipsis would, whose curvature in A were equal to that of the line ALB: that is, the proportion of the distance of the earth T from the centre of the ellipsis to its axis, will be greater in AMB than in the other; but

that

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that other is the ellipſis which the moon would deſcribe, if the power acting upon it in the point A were altered in the reciprocal duplicate proportion of the diſtance; and conſequently the moon being drawn more forcibly towards the earth, it will deſcend nearer to it. On the other hand, when the apogeon recedes, the power acting on the moon increaſes with the decreaſe of diſtance, in leſs than the duplicate proportion of the diſtance, and therefore the moon is leſs impelled towards the earth, and will not deſcend ſo low. Now, ſuppoſe, in the former of theſe figures, that the apogeon A is in the ſituation where it is approaching towards the conjunction or oppoſition of the ſun; in this caſe its progreſſive motion will be more and more accelerated. Here ſuppoſe the moon, after having deſcended from A through the orbit AE as far as F, where it is come to its neareſt diſtance from the earth, aſcends again up the line FG. As the motion of the apogeon is here more and more accelerated, it is plain that the cauſe of its motion muſt alſo be on the increaſe; that is, the power by which the moon is drawn to the earth, will decreaſe with the increaſe of the moon's diſtance in her aſcent from F, in a greater proportion than that wherewith it is increaſed with the decreaſe of diſtance in the moon's deſcent to it. Conſequently the moon will aſcend to a greater diſtance than AT from whence it is deſcended; therefore the proportion of the greateſt diſtance of the moon to the leaſt is increaſed. But further, when the moon again deſcends, the power will increaſe yet farther with the decreaſe of diſtance than in the laſt aſcent it increaſed with the agmentation of diſtance. The moon therefore muſt deſcend nearer to the earth than it did before, and the proportion of the greateſt diſtance to the leaſt be yet more increaſed. Thus, as long as the apogeon is advancing to the conjunction or oppoſition, the proportion of the greateſt diſtance of the moon from the earth to the leaſt will continually increaſe; and the elliptical orbit to which the moon's motion is referred, will become more and more eccentric. As ſoon, however, as the apogeon is paſſed the conjunction or oppoſition with the ſun, its progreſſive motion abates, and with it the proportion of the greateſt diſtance of the moon from the earth to the leaſt will alſo diminiſh: and when the apogeon becomes retrograde, the diminution of this proportion will be ſtill farther continued on, till the apogeon comes into the quarter; from thence this proportion, and the eccentricity of the orbit, will increaſe again. Thus the orbit of the moon is moſt eccentric when the apogeon is in conjunction with the ſun, or in oppoſition to it, and leaſt of all when the apogeon is in the quarters. Theſe changes in the nodes, the inclination of the orbit to the plane of the earth's motion, in the apogeon and in the eccentricity, are varied like the other inequalities in the motion of the moon, by the different diſtance of the earth from the ſun being greateſt when their cauſe is greateſt; that is, when the earth is neareſt the ſun. Sir Iſaac Newton has computed the very quantity of many of the moon's inequalities. That acceleration of the moon's motion which is called the variation, when greateſt, removes the luminary out of the place in which it would otherwiſe be found, ſomewhat more than half a degree. If the moon, without diſturbance from the ſun, would have deſcribed a circle concentrical to the earth, his action would cauſe her approach nearer in the conjunction and oppoſition than in the quarters, nearly in the proportion of 69 to 70. It has already been mentioned, that the nodes perform their period in almoſt 19 years. This has been found by obſervation; and the computations of Sir Iſaac aſſign to them the ſame period. The inclination of the moon's orbit, when leaſt, is an angle about one-eighteenth of that which conſtitutes a right angle; and the difference between the greateſt and leaſt inclination is about one-eighteenth of the leaſt inclination, according to our author's computations: which is alſo agreeable to the general obſervations of aſtronomers. The motion of the apogeon and the changes in the eccentricity have not been computed by Sir Iſaac.

297 Computation of the lunar inequalities

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298 How to compute the inequalities of the motions of Jupiter's ſatellites.

The ſame incomparable geometer ſhows how, by comparing the periods of the motions of the ſatellites which revolve round Jupiter and Saturn with the period of our moon round the earth, and the periods of thoſe planets round the ſun with our earth's motion, the inequalities in the motion of thoſe ſatellites may be computed from thoſe of our moon, excepting only the motion of the apogeon; for the orbits of thoſe ſatellites, as far as can be diſcerned by us at this diſtance, appearing little or nothing eccentric, this motion, as deduced from the moon, muſt be diminiſhed.

§ 4. *Of the Nature and Motions of the Comets.*

That theſe bodies are not meteors in our air is manifeſt, becauſe they riſe and ſet in the ſame manner as the moon and ſtars. The aſtronomers have gone ſo far in their inquiries concerning them as to prove by their obſervations that they moved in the celeſtial ſpaces beyond the moon; but they had no notion of the path which they deſcribed. Before the time of our author, it was ſuppoſed that they moved in ſtraight lines; and Des Cartes, finding that ſuch a motion would interfere with his vortices, removed them entirely out of the ſolar ſyſtem. Sir Iſaac Newton, however, diſtinctly proves from aſtronomical obſervation, that the comets paſs through the planetary regions, and are generally inviſible at a ſmaller diſtance than that of Jupiter. Hence, finding that they were evidently within the ſphere of the ſun's action, he concludes, that they muſt neceſſarily move about the ſun as the planets do; and he proves, that the power of the ſun being reciprocally in the duplicate proportion of the diſtance, every body acted upon by him muſt either fall directly down, or move about him in one of the conic ſections, viz. either the ellipſis, parabola, or hyperbola. If a body which deſcends towards the ſun as low as the orbit of any planet, move with a ſwifter motion than the planet, it will deſcribe an orbit of a more oblong figure than that of the planet, and have at leaſt a longer axis. The velocity of the body may be ſo great, that it ſhall move in a parobola; ſo that having once paſſed the ſun, it ſhall aſcend for ever without returning, though the ſun will ſtill continue in the focus of that parabola; and with a velocity ſtill greater, they will move in an hyberbola. It is, however, moſt probable, that the comets move in very eccentric ellipſis, ſuch as is repreſented in fig. 135. where S repreſents the ſun, C the comet, and ABDE its orbit; wherein the diſtance of S and D far exceeds that of S and A. Hence thoſe bodies are ſometimes found at a moderate diſtance from the ſun, and appear within

299 Comets generally inviſible until they come nearer than Jupiter.

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within the planetary regions; at other times they ascend to vaſt diſtances, far beyond the orbit of Saturn, and thus become inviſible.

300 They move in eccentric ellipſes.

That the comets do move in this manner is proved by our author from computations built upon the obſervations made by many aſtronomers. Theſe computations were made by Sir Iſaac Newton himſelf upon the comet which appeared toward the latter end of the year 1680 and beginning of 1681, and the ſame were proſecuted more at large by Dr Halley upon this and other comets. They depend on this principle, that the eccentricity of the orbits of the comets is ſo great, that if they are really elliptical, yet that part of them which comes under our view approaches ſo near to a parabola that they may be taken for ſuch without any ſenſible error, as in the foregoing figure the parabola FAG, in the lower part of it about A, differs very little from the ellipſis DEAB; on which foundation Sir Iſaac teaches a method of finding the parabola in which any comet moves, by three obſervations made upon it in that part of its orbit where it agrees neareſt with a parabola: and this theory is confirmed by aſtronomical obſervations; for the places of the comets may thus be computed as exactly as thoſe of the primary planets. Our author afterwards ſhows how to make uſe of any ſmall deviation from the parabola which may be obſerved, to determine whether the orbits of the comets be elliptical or not; and thus to know whether or not the ſame comet returns at different ſeaſons. On examining by this rule the comet of 1680, he found its orbit to agree more exactly with an ellipſis than a parabola, tho' the ellipſis be ſo very eccentric, that it cannot perform its revolution in 500 years. On this Dr Halley obſerved, that mention is made in hiſtory of a comet with a ſimilar large tail, which appeared three ſeveral times before. The firſt was before the death of Julius Cæſar; and each appearance happened at the interval of 575 years, the laſt coinciding with the year 1680. He therefore calculated the motion of this comet to be in ſuch an eccentric orbit, that it could not return in leſs than 575 years; which computations agree yet more perfectly with the obſervations made on this comet than any parabolic orbit will do. To compare together different appearances of the ſame comet, is indeed the only method of diſcovering with certainty the form of its orbit; for it is impoſſible to diſcover the form of one ſo exceedingly eccentric from obſervations taken in a ſmall part of it. Sir Iſaac Newton therefore propoſes to compare the orbits, on the ſuppoſition that they are parabolical, of ſuch comets as appear at different times, for if we find the ſame orbit deſcribed by a comet at different times, in all probability it will be the ſame comet that deſcribes it. Here he remarks from Dr Halley, that the ſame orbit very nearly agrees to two appearances of a comet about the ſpace of 75 years diſtance; ſo that if theſe two appearances were really of the ſame comet, the tranſverſe axis of its orbit would be 18 times that of the axis of the earth's orbit; and therefore, when at its greateſt diſtance from the ſun, this comet would be removed not leſs than 35 times the mean diſtance of the earth from the ſame luminary.

301 How to calculate the motion of a comet.

Even this is the leaſt diſtance aſſigned by our author to any comet in its greateſt elongation from the ſun; and on the foundation of Dr Halley's computations it was expected in the year 1758 or 1759.

The Aſtronomer Royal adverti ſes us of the expected return of the comet of 1532 and 1661, in the latter end of the year 1788, or beginning of 1789, in the following particulars. Nature and Motions of the Comets.

"The elements of the orbits of the comets obſerved by Apian in 1532, and by Hevelius in 1661, are ſo much alike as to have induced Mr Halley to ſuppoſe them to be one and the ſame comet; and aſtronomers ſince have joined in the ſame opinion. Hence it ſhould return to its perihelium the 27th of April 1789. But from the diſturbances of the planets, it will probably come a few months ſooner. It will firſt be ſeen in the ſouthern parts of the heavens, if any aſtronomers ſhould watch for it in ſituations near the line, or in ſouthern climates, in the courſe of the year 1788, and probably not before the month of *September*. Aſtronomers who may happen to be in thoſe parts will be enabled to direct their teleſcopes for diſcovering it as early as poſſible, by being furniſhed with the following elements of its orbit:

The perihelium diſtance	0.44851
Place of aſcending node	2' 24° 18'
Inclination of the orbit to the ecliptic	32° 36'
Perihelium forwarder in the orbit than the aſcending node	33° 28'

time of the perihelium in the latter end of the year 1788, or beginning of 1789. Its motion is direct. If it ſhould come to its perihelium on *January* 1, 1789, it might be ſeen in the ſouthern parts of the world with a good achromatic teleſcope about the middle of *September*, towards the middle of *Piſces*, with 55° ſouth latitude, and 53 ſouth declination."

Sir Iſaac Newton obſerves, that as the great eccentricity of the orbits of comets renders them very liable to be diſturbed by the attraction of the planets and other comets, it is probably, to prevent too great diſturbances from theſe, that while all the planets revolve nearly in the ſame plane, the comets are diſpoſed in very different ones, and diſpoſed all over the heavens; that when in their greateſt diſtance from the ſun, and moving ſloweſt, they might be removed as far as poſſible out of the reach of each other's action. The ſame end is likewiſe anſwered in theſe comets, which by moving ſloweſt in the aphelion or remoteſt diſtance from the ſun, deſcend neareſt to it by placing their aphelion at the greateſt height from the ſun. See more on the ſubject of comets by Sir Iſaac, Sect. III. n° 169.

§ 5. *Of the Bodies of the Sun and Planets, with the Method of computing the Quantity of Matter they contain.*

Our author having proved, as has been related, that the primary planets and comets are retained in their orbits by a power directed towards the ſun, and that the ſecondaries are alſo retained by a power of the like kind directed to the centre of their primaries, proceeds next to demonſtrate, that the ſame power is diffuſed through their whole ſubſtance and inherent in every particle. For this purpoſe he ſhows firſt, that each of the heavenly bodies attracts the reſt and other bodies with ſuch different degrees of force, as that the force of the ſame attracting body is exerted on others exactly in proportion to the quantity of matter contained in the body attracted. The firſt proof of this he brings from experiments made on bodies here on earth

302 Attractive power diffuſed throughout the ſubſtance of all matter.

earth. The power by which the moon is influenced has been already ſhown to be the ſame with that which we call *gravity*. Now, one of the effects of the principle of gravity is, that all bodies deſcend by this force from equal heights in equal times. This was taken notice of long ago; and particular methods have been invented to ſhow, that the only cauſe why ſome bodies were obſerved to fall in a ſhorter time than others was the reſiſtance of the air. As theſe methods, however, have been found liable to ſome uncertainty, Sir Iſaac Newton had recourſe to experiments made on pendulums. Theſe vibrate by the ſame power which makes heavy bodies fall to the ground; but if the ball of any pendulum of the ſame length with another were more or leſs attracted in proportion to the quantity of ſolid matter it contains, that pendulum muſt then vibrate faſter or ſlower than the other. Now the vibrations of pendulums continue for a long time, and the number of vibrations they make may be eaſily determined without any ſuſpicion of error; ſo that this experiment may be extended to what exactneſs we pleaſe: and Sir Iſaac aſſures us, that he examined in this way ſeveral ſubſtances, as gold, ſilver, lead, glaſs, ſand, common ſalt, wood, water, and wheat; in all which he found not the leaſt deviation from the theory, tho' he made the experiment in ſuch a manner, that in bodies of the ſame weight, a difference in the quantity of their matter leſs than the thouſandth part of the whole would have diſcovered itſelf. It appears, therefore, that all bodies are made to deſcend here by the power of gravity with the ſame degree of ſwiftneſs. This deſcent has already been determined at 16¼ feet in a ſecond from the beginning of their fall. It has alſo been obſerved, that if any terreſtrial body could be conveyed as high up as the moon, it would deſcend with the very ſame degree of velocity with which the moon is attracted toward the earth; and therefore that the power of the earth upon the moon bears the ſame proportion it would have upon thoſe bodies at the ſame diſtance as the quantity of matter in the moon bears to the quantity in thoſe bodies. Thus the aſſertion is proved in the earth, that its power on every body it attracts is, at the ſame diſtance from the earth, proportional to the quantity of ſolid matter in the body acted upon. As to the ſun, it has been ſhown, that the power of his action upon the ſame primary planet is reciprocally in the duplicate proportion of its diſtance; and that the power of the ſun decreaſes throughout in the ſame proportion, is teſtified by the motion of the planets traverſing the whole planetary region. This proves, that if any planet were removed from the ſun to any diſtance whatever, the degree of its acceleration towards the ſun would yet be reciprocally in the duplicate proportion of their diſtance. But it has already been proved, that the degree of acceleration given to the planets by the ſun is reciprocally in the duplicate proportion of their reſpective diſtances; all which compared together, puts it out of doubt, that the power of the ſun upon any planet removed into the place of any other, would give it the ſame velocity of deſcent as it gives that other; and conſequently that the ſun's action upon different planets at the ſame diſtance would be proportionable to the quantity of matter in each. It has likewiſe been ſhown, that the ſun attracts the primary planets and their reſpective ſecondaries, when at the ſame diſtance, in ſuch a manner as to communicate to both the ſame degree of velocity; and therefore the force wherewith the ſun acts on the ſecondary planet bears the ſame proportion to the force wherewith it attracts the primary, as the quantity of matter in the ſecondary planet bears to the quantity of matter in the primary. This property therefore is found in the ſun with regard to both kinds of planets; ſo that he poſſeſſes the ſame quality found in the earth, viz. that of acting on bodies with a degree of force proportional to the quantity of matter they contain.

303 Properties of gravity demonſtrated by pendulums.

304 Attraction proportioned to the quantity of matter

This point being granted, it is hardly to be ſuppoſed that the power of attraction with which the other planets are endowed, ſhould be different fom that of the earth, if we conſider the ſimilitude of theſe bodies: and that it does not in this reſpect, is farther evident from the ſatellites of Saturn and Jupiter which are attracted according to this law; that is, in the ſame proportion to their diſtances that their primaries are attracted by the ſun. So that what has been concluded of the ſun in relation to the primary planets may be juſtly concluded of thoſe primaries in reſpect to their ſecondaries; and in conſequence of that likewiſe in regard to all other bodies, viz. that they will attract every other body in proportion to the quantity of ſolid matter it contains. Hence it follows, that this attraction extends itſelf to every particle of matter in the attracted body, and that no proportion of matter is exempted from the influence of theſe bodies to which this attractive power has been proved to belong.

305 Attraction acts equally throughout the bodies in the univerſe.

Here we may remark, that the attractive power both of the ſun and planets appears to be the ſame in all; for it acts in each in the ſame proportion to the diſtance, and in the ſame manner acts alike upon every particle of matter. This power, therefore, in the ſun and planets, is not of a different nature from the power of gravity in the earth: and this enables us to prove, that the attracting power lodged in the ſun and planets belongs likewiſe to every part of them; and that their reſpective powers upon the ſame body are proportional to the quantity of matter of which they are compoſed; for inſtance, that the force with which the earth attracts the moon, is to the force with which the ſun would attract it at the ſame diſtance, as the quantity of ſolid matter in the earth is to that in the ſun.

Before we proceed to a full proof of theſe aſſertions, it will be neceſſary to ſhow that the third law of motion, viz. That action is equal to reaction, holds good in attractive powers as well as in any other. The moſt remarkable force of this kind with which we are acquainted, next to that of gravity, is the attraction the loadſtone has for iron. Now if a loadſtone and piece of iron were both made to ſwim on water, both of them would move towards each other, and thus the attraction would be ſhown to be mutual; and when they meet, they will mutually ſtop each other: which ſhows that their velocities are reciprocally proportioned to the quantities of ſolid matter in each; and that by the ſtone's attracting the iron, it receives as much motion itſelf, in the ſtrict philoſophic ſenſe of the word, as it communicates to the iron: for it is proved from experiments on the percuſſion of bodies, that if two meet with velocities reciprocally proportional to the reſpective bodies, they will be ſtopt by the concourſe, unleſs they meet with ſome other velocity, or their ela[ci]ty

Fig. 153

Saturn ♄

Jupiter ♃

Mars ♂

Earth ⊖ & Moon ☾

Venus ♀

Mercury ☿

Fig. 152

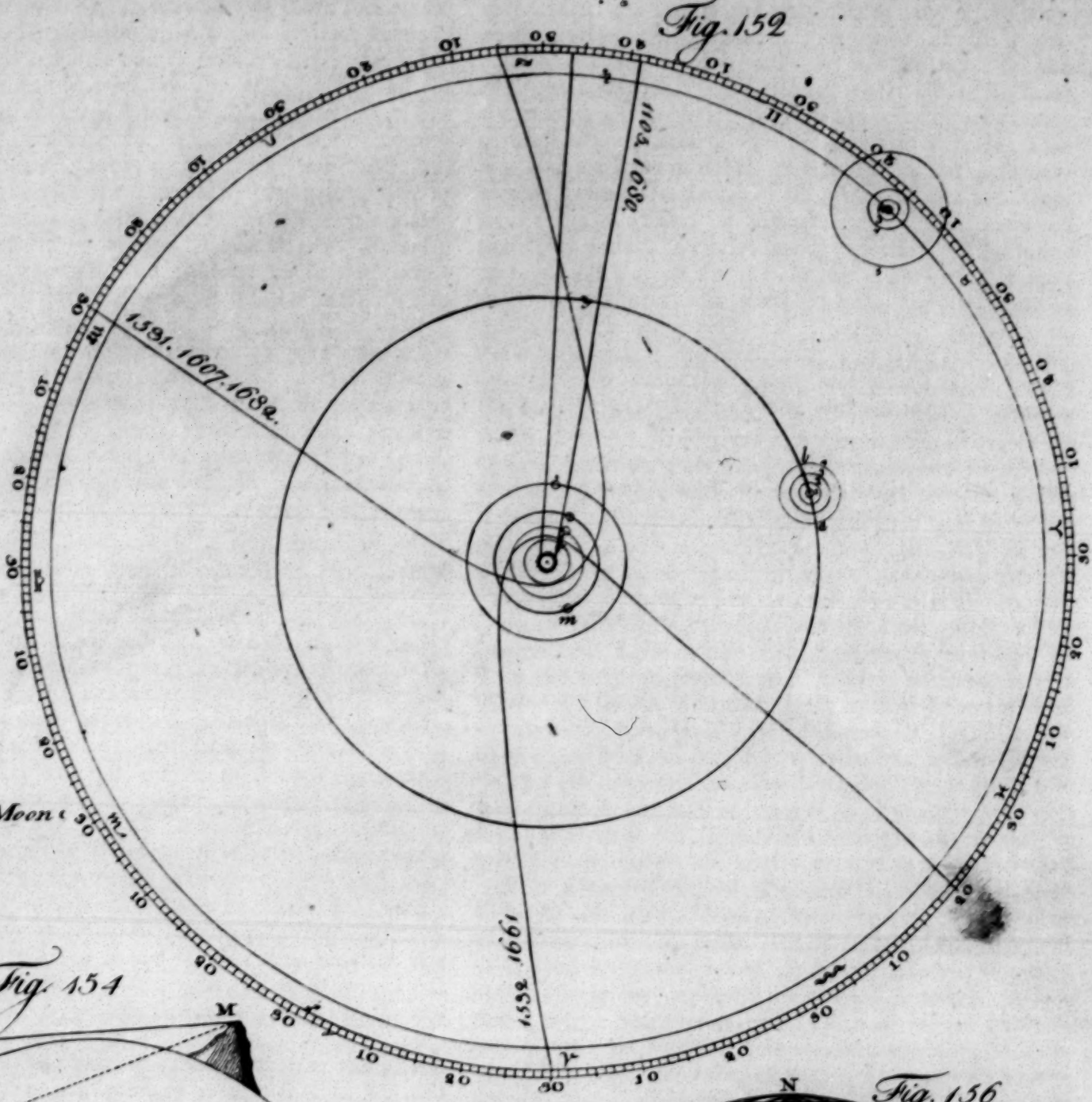

Fig. 154

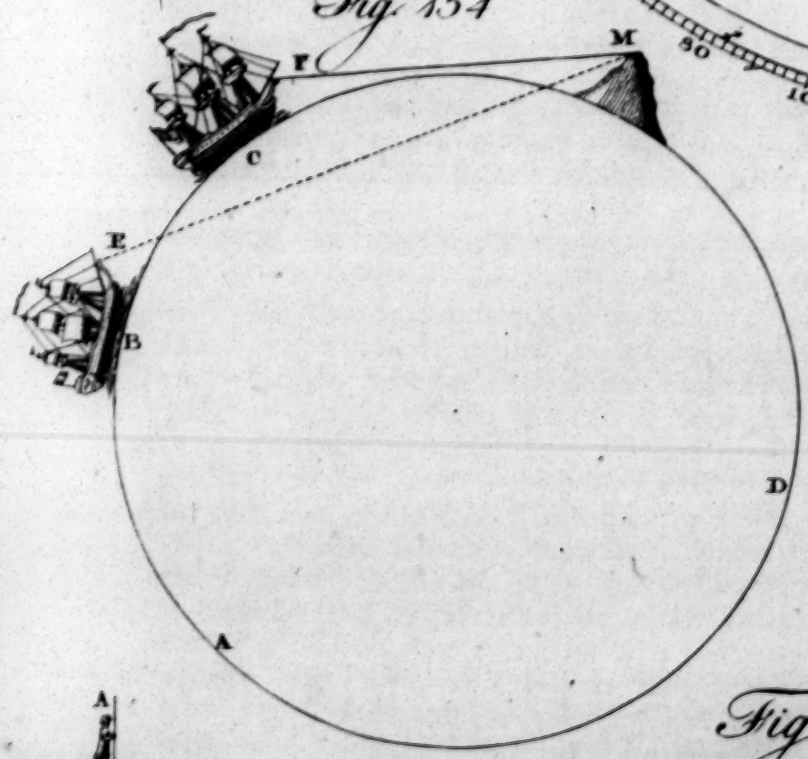

Fig. 156

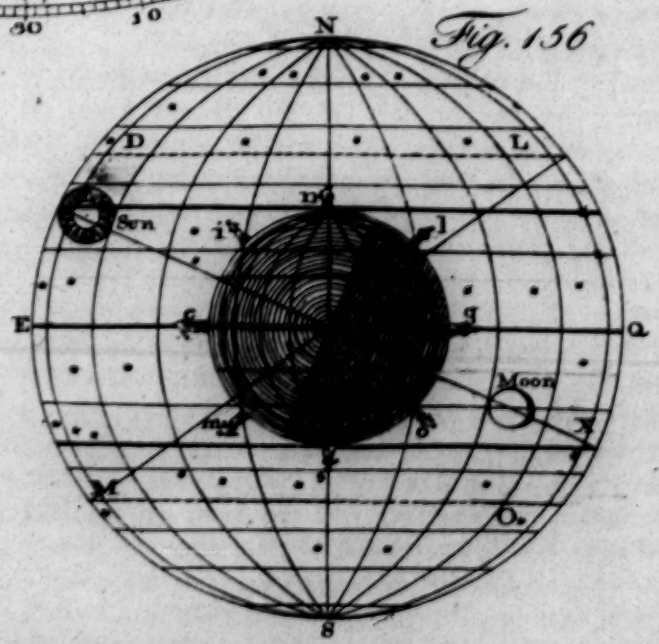

Fig. 155

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Of the Bodies of the Sun and Planets.

city put them into fresh motion. Hitherto, however, for the sake of brevity, in speaking of these forces, we have ascribed them to the body which is least moved; as when we called the power which exerts itself between the sun and planets, *the attractive power of the sun:* but to speak more correctly, we should rather call this power in any case the force which acts between the sun and earth, between the earth and moon, &c. for both the bodies are moved by the power acting between them, in the same manner as when two bodies are tied together by a rope, if that should shrink by being wet or otherwise, and thereby cause the bodies to approach; by drawing both, it will communicate to both the same degree of motion, and cause them to approach each other with velocities proportional to their quantities of matter. From this mutual action of the sun and planets upon each other, it follows, as has been already mentioned, that they both revolve about their common centre of gravity. Thus let A (in fig. 136.) represent the sun, B, a planet and C their common centre of gravity. If these bodies were once at rest, they would directly approach each other by their mutual attraction, and that with such velocities, that their common centre of gravity would remain at rest, and they would meet in that point. Were the planet B to receive an impulse, as in the direction DE, this would prevent the two bodies from falling together; but their common centre of gravity would be put into motion in the direction of the line CF, equidistant from BE. In this case Sir Isaac Newton proves, that the sun and planet would describe round their common centre of gravity similar orbits, while that centre would proceed with an uniform velocity in the line CF, and so the system of the two bodies would move on with the centre of gravity without end. In order to keep the system in the same place, it is necessary, that when the planet received its impulse in the direction BE, the sun should receive such another the contrary way, so as to keep the centre of gravity C without any motion, in which case it would always remain fixed.

306 Why the sun and planets revolve about their common centre of gravity.

Thus we may understand in what manner the action between the sun and planets is mutual. It has also been shown, that the power which acts between the sun and primary planets is altogether of the same nature with that which acts between the secondary planets and their primaries, or which acts between the earth and bodies near its surface. It has also been already proved, that in different planets the force of the sun's action upon each at the same distance would be proportional to the quantity of solid matter contained in the planet: therefore the reaction of the planet on the sun at the same distance, or the motion which he would receive from each planet, would also be proportional to the quantity of matter in the planet; that is, these planets, at the same distance, would act on the same body with degrees of strength proportioned to the quantity of solid matter contained in each.

307 The smallest particles of matter attract each other according to the same law.

In the next place, our author deduces from the principles above demonstrated, that each of the particles out of which the sun, moon, and planets, are formed, exert their power of gravitation by the same law, and in the same proportion to the distance, as the great bodies they compose. For this purpose, he first demonstrates, that if a globe were compounded of particles which will attract the particles of any other body reciprocally in the duplicate proportion of their distances, the whole globe will attract the same in the reciprocal duplicate proportion of their distances from the centre of the globe, provided it be of equal density throughout. Hence also he deduces the reverse; that if a globe acts upon distant bodies by the law just now specified, and the power of the globe be derived from its being composed of attracting particles, each of these will attract after the same proportion. The manner of deducing this is as follows: The globe is supposed to act upon the particles of a body without it constantly in the reciprocal duplicate proportion of their distances from the centre; and therefore, at the same distance from the globe, on which side soever the body be placed, the globe will act equally upon it. Now, because if the particles of which the globe is composed acted upon those without in the reciprocal duplicate proportion of their distances, the whole globe would act upon them in the same manner as it does; therefore, if the particles of the globe have not all of them that property, some must act stronger than in that proportion, whilst others act weaker: and if this be the condition of the globe, it is plain, that when the body attracted is in such a situation in respect of the globe that the greater number of the strongest particles are nearest to it, the body will be more forcibly attracted than when, by turning the globe about, the greater quantity of weak particles would be nearest, though the distance of the body should remain the same from the centre of the globe; which is contrary to what was at first remarked, that the globe acts equally on all sides.

Of the Bodies of the Sun and Planets.

It is farther deduced from these propositions, that if all the particles of one globe attract all the particles of another in the proportion already mentioned, the attracting globe will act upon the other in the same proportion to the distance between the centre of the globe which attracts and the centre of that which is attracted: and farther, that the proportion holds true, though either or both of the globes be composed of dissimilar parts, some rarer, and some more dense; provided only, that all the parts in the same globe, equally distant from the centre, be homogeneous, and likewise if both globes attract each other.

308 Attraction an universal property of matter.

Thus has our author shown that this power in the great bodies of the universe is derived from the same being lodged in every particle of the matter which composes them; and consequently that it is no less than universal in matter, though the power be too minute to produce any visible effects on the small bodies with which we are conversant by their action on one another. In the fixed stars indeed we have no particular proof that they have this power, as we find no appearance to demonstrate that they either act or are acted upon by it. But since this power is found to belong to all bodies whereon we can make observation, and we find that it is not to be altered by any change in the shape of bodies, but accompanies them in every form, without diminution, remaining ever proportional to the quantity of solid matter in each; such a power must without doubt universally belong to matter.

Of the Bodies of the Sun and Planets.

All this naturally follows from a conſideration of the phenomena of thoſe planets which have ſecondaries revolving about them. By the times in which theſe ſatellites perform their revolutions, compared with their diſtances from their reſpective primaries, the proportion between the power with which one primary attracts his ſatellites and the force with which any other attracts his will be known; and the proportion of the power with which any planet attracts his ſecondary to the power with which it attracts a body at its ſurface, is found by comparing the diſtance of the ſecondary planet from the centre of the primary to the diſtance of the primary planet's ſurface from the ſame: and from hence is deduced the proportion between the power of gravity upon the ſurface of one planet to the gravity upon the ſurface of another. By the like method of comparing the periodical time of a primary planet about the ſun with the revolution of a ſatellite about its primary, may be found the proportion of gravity or of the weight of any body on the ſurface of the ſun, to the gravity or to the weight of the ſame body upon the ſurface of the planet which carries about the ſatellite. By computations of this kind it is found, that the weight of any body on the ſurface of the ſun will be about 23 times as great as on the ſurface of the earth; about 10 times as great as on the ſurface of Jupiter; and near 19 times as great as on Saturn. The quantity of matter contained in each of theſe bodies is proportional to the power it has upon a body at a given diſtance. Thus it is found, that the ſun contains 1067 times as much matter as Jupiter; Jupiter 158$\frac{1}{2}$ times as the earth, and 2$\frac{1}{2}$ times as much as Saturn. The diameter of the ſun, according to the data with which Sir Iſaac Newton was furniſhed, was calculated at 92 times, that of Jupiter about 9 times, and that of Saturn about 7 times as large as the diameter of the earth.

309 How to determine the power of gravity on any of the planets.

310 Denſities of the heavenly bodies.

By comparing the quantities of matter in each of theſe bodies with their reſpective magnitudes their denſities are likewiſe eaſily diſcovered; the denſity of every body being meaſured by the quantity of matter contained under the ſame bulk. Thus the earth is found 4$\frac{1}{2}$ times more denſe than Jupiter, while Saturn has only between two-thirds and three-fourths of the denſity of the latter, and the ſun has only one-fourth part of the denſity of the earth. From all this our author draws the following concluſions, viz. That the ſun is rarefied by its great heat; and of the three planets above-mentioned, the moſt denſe is that neareſt the ſun. This it was highly reaſonable to expect, the denſeſt bodies requiring the greateſt heat to agitate and keep their parts in motion; as on the contrary, the planets which are more rare would be rendered unfit for their office by the intenſe heat to which the denſer are expoſed. Thus the waters of our ſeas, if removed to the diſtance of Saturn would remain perpetually frozen, and at Mercury would conſtantly boil. The denſities of the planets Mars, Venus, Mercury, and the *Georgium Sidus*, as they are not attended with planets on which many obſervations have been made, cannot be aſcertained. From analogy, however, we ought to conclude, that the inferior planets, Venus and Mercury are more denſe than the earth, Mars more rare, and the Georgium Sidus much more rare, than any of the reſt.

Sect. V. *The Newtonian Doctrine applied more particularly to the Explication of the Celeſtial Phenomena.*

Particular Explication of the Celeſtial Phenomena.

From the general account of thoſe laws by which the univerſe is upheld, we now proceed to give an explanation of the particular parts of which it is compoſed. Thoſe which are moſt expoſed to our reſearches, beſides the Earth we inhabit, are the Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, and the Georgium Sidus (ſee fig. 119.). The ſun, an immenſe globe of fire, is ſituated near the centre of the ſyſtem, round which he turns by a ſmall and irregular motion, according as the common centre of gravity betwixt him and the planets, which is the true centre of the ſyſtem, varies by their different poſitions on this or that ſide of him. All the planets move round this common centre of gravity together with the ſun; but the latter, by reaſon of his vaſt bulk, is ſo near the true centre, that the motions of the celeſtial bodies are by aſtronomers always referred to the centre of the ſun as the point round which they are directed. The motions of all of them are performed the ſame way, viz. from weſt to eaſt; and ſome comets have been obſerved to move alſo in this way, though the motion of others has been directly contrary. This motion, from weſt to eaſt, is ſaid to be in the order of the ſigns, or *in conſequence*, as has been already mentioned, with regard to the moon; while that from eaſt to weſt is in *antecedence*, or contrary to the order of the ſigns. Though all of them, however, revolve round the ſun, their motions, as we have already obſerved, are not in the ſame plane, but inclined to one another by ſmall angles: and the way in which we compute this inclination is by conſidering the orbit of the earth as a ſtandard, and calculating the angle which each of their orbits makes with it.

311 Heliocentric circles of the planets.

To a ſpectator placed in the ſun, all the planets would appear to deſcribe circles annually in the heavens; for though their motions are really elliptical, the eccentricity is ſo ſmall, that the difference between them and true circles is not eaſily perceived even on earth; and at the ſun, whether great or ſmall, it would entirely vaniſh. Theſe circles, which in ſuch a ſituation would appear to be annually deſcribed among the fixed ſtars are called the *heliocentric circles* of the planets; and if we ſuppoſe the orbits of the planets to be extended to the extreme bounds of the creation, they would deſcribe among the fixed ſtars thoſe circles juſt mentioned. To a ſpectator in the ſun, the comets, though moving in the moſt eccentric orbits, would alſo appear to deſcribe circles in the heavens; for though their orbits are in reality very long ellipſes, the planes of them extended to the heavens would mark a great circle thereon, whereof the eye would be the centre; only, as the real motion is in an ellipſis, the body would appear to move much more ſlowly in ſome part of the circle than another, and to differ exceſſively in magnitude. To an inhabitant of any planet, however, the ſun appears to go round in its own heliocentric circle, or to deſcribe in the heavens that ſame curve which the planet would appear to do if ſeen from the ſun. Thus (fig. 137), when the earth is at *a*, if

we

Particular Explication of the Celeſtial Phenomena.

we draw a line from *a* through the ſun at S, the point G, in the ſphere of the heavens where the line terminates, is the place where the ſun then appears to an inhabitant of the earth. In a month's time the earth will be got from *a* to *b*; draw a line then through the ſun, and its extremity at H will point out his apparent place at that time. In like manner, if we draw lines from the earth in the twelve ſeveral ſituations in which it is repreſented for the twelve months of the year, the ſun's apparent place will be found as above, and ſo it would be found by a ſpectator placed in Venus or any other planet.

312 Ecliptic, why ſo named.

The heliocentric circle of the earth is called the *ecliptic*; becauſe eclipſes of the ſun or moon can only happen when the latter is in or near it, as will afterwards be more particularly explained. By ſome ancient writers it has been called the circle of the ſun, or the oblique circle, becauſe it cuts the equator at oblique angles. It is alſo called by Ptolemy the circle which paſſes through the midſt of the animals; becauſe the twelve conſtellations through which it paſſes were anciently all repreſented by animals, or parts of them, though now the *balance* is introduced in place of the claws of the *ſcorpion*. For this reaſon, a belt or hoop taken in the concave ſphere of the heavens about 10 degrees on each ſide of the ecliptic, is called the *zodiac*, from a Greek word which ſignifies an animal; and the conſtellations through which the ecliptic is drawn, are called the conſtellations of the zodiac.

313 Zodiac.

314 How to determine the ſun's place.

Though the ſun, as we have ſaid, apparently goes round the earth annually in the circle juſt mentioned, we cannot determine his place by mere inſpection as we can do that of any of the other heavenly bodies; for the fixed ſtars are the only marks by which we can determine the places of any of the celeſtial bodies, and the ſuperior brightneſs of the ſun renders them totally inviſible except in the time of a great eclipſe when his light is for a time totally obſcured. But though we cannot know the place of the ſun directly, it is eaſily found from a knowledge of thoſe fixed ſtars which are oppoſite to him. Thus, in fig. 137. ſuppoſe it the time of the year in which the earth it at *g*, if we know that the point G is then diametrically oppoſite to the ſun, we know that A, its oppoſite, is the ſun's place; and conſequently, by finding the places throughout the year diametrically oppoſite to the ſun, as GHIKLM ABCDEF, we may be aſſured that in theſe times the ſun's place was in the points ABCDEFGHIKLM. The point in the heavens diametrically oppoſite to the ſun may be known every night at twelve o'clock when the ſtars are viſible; for the ſtar which has an elevation above the horizon at that time equal to the ſun's depreſſion below it, is directly oppoſite to him.

315 Latitude, declination, &c. explained.

The ecliptic being thus found, the latitude of the moon or any ſtar is counted by its diſtance from the ecliptic, as the latitude of places on earth is counted by their diſtance from the equator; and is marked upon circles drawn through the pole of the ecliptic, and perpendicular to its plane, as the latitude of places is marked on one of the meridians of a terreſtrial globe. Theſe are called *circles of latitude*, and each of them is ſuppoſed to divide the celeſtial concave into two equal hemiſpheres; and the *declination* of any celeſtial body is its deviation from the ecliptic towards the celeſtial equator perpendicular to that of the earth.

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The latitude of any planet is either heliocentric or geocentric. The heliocentric latitude is its diſtance from the ecliptic as ſeen from the ſun, and its geocentric as ſeen from the earth, and is conſiderably different from the former. With the fixed ſtars indeed it is otherwiſe; for their diſtance is ſo vaſt, that the whole diameter of the earth's orbit is but a point in compariſon with it. For this reaſon, whatever part of its orbit the earth may be in, the fixed ſtars always appear to keep the ſame place; but with reſpect to the planets, the orbit of the earth, or *magnus orbis*, as it has ſometimes been called, bears a very conſiderable proportion, excepting only to the Georgium Sidus, of whoſe diſtance the diameter of the earth's orbit forms little more than a tenth part; and therefore all calculations with regard to that ſtar are much more difficult than the reſt. The apparent places of the planets therefore are conſiderably altered by the earth's change of place as well as by their own motions; ſo that though a planet ſhould ſtand ſtill for a whole year, it would nevertheleſs appear to us to deſcribe a circle round the heavens, as in that ſpace of time we would have been carried by the earth round the ſun, and have continually taken a view of it from different ſtations. As the orbits of the planets are inclined in different angles to the ecliptic, it thence happens, that the heliocentric latitude of any planet is almoſt always different from its geocentric latitude. Thus, let AB, fig. 138. be the orbit of the earth, CD the orbit of Venus, viewed with the eye in their common ſection, wherein they appear ſtraight lines; let E and F be two oppoſite points of the ecliptic; and ſuppoſe Venus to be in the point C in her utmoſt north limit. If ſhe were at that time viewed from the ſun S, ſhe would appear in the point of the heavens marked H, and her heliocentric latitude is then FH: but if viewed from the earth in B, ſhe will appear at *g*; at which time her heliocentric latitude is FH, and her geocentric only F*g*. When at I, her apparent place is at K, her heliocentric latitude FH, and her geocentric FK; but when the earth is at A, her apparent place will then be at G, and her geocentric latitude EG, while her heliocentric is only FH as before.

316 How to find the geocentric latitude of a ſuperior planet.

The two planets, Mercury and Venus, whoſe orbits are included in that of the earth, are called *inferior*; and Mars, Jupiter, Saturn, and the Georgium Sidus, whoſe orbits include that of the earth, are called *ſuperior*; and from the circumſtance juſt mentioned, they muſt preſent very different appearances in the heavens, as will afterwards be particularly explained. The geocentric latitude of a ſuperior planet may be underſtood from fig. 139. Let AB be the orbit of the earth, CD that of Mars, both viewed with the eye in their common ſection continued, by which they appear in ſtraight lines. Let E and F be oppoſite points of the ecliptic, and ſuppoſe Mars to be in his ſouth limit at C. If he were at that time viewed from S, the centre of the ſun, he would appear in the ſphere of the heaven at the point H; in which caſe his heliocentric latitude would be FH: But when viewed in C from the earth, or from its centre, which in this caſe is ſuppoſed to be the ſtation of the ſpectator, he will appear to be in different places of the heavens according to the poſition of

Particular Explication of the Celestial Phenomena.

the earth. When the earth, for instance, is at B, the place of Mars will appear to be at *g*, and his geocentric latitude will be F *g*. When the earth is at A, his apparent place will be in G, and his geocentric latitude FG: and in like manner, supposing the earth to be in any other part of its orbit, as in I or K, it is easy to see, that his apparent places, as well as geocentric latitudes at those times, will be different.

317 Nodes of a planet.

The two points where the heliocentric circle of any planet cuts the ecliptic are called its *nodes*: and that which the planet passes through as it goes into north latitude, is called the *ascending* node, and is marked thus ☊; and the opposite to this is called the *descending* node, and is marked ☋. A line drawn from one node to the other is called the *line of the nodes of the planet*, which is the common section of the plane of the ecliptic, and that of the planet produced on each side to the fixed stars.

318 Zodiac and signs explained.

The zodiac, of which we have already given some account, is either *astral* or *local*. The astral is divided into 12 unequal parts, because it contains 12 celestial constellations, some of which are larger than others. This continues always invariably the same; because the same stars now go to the making up of the different constellations as formerly, excepting some small variations to be afterwards explained. The local zodiac is divided into twelve equal parts, each containing 30 degrees, called *signs*. These are counted from the point where the equator and ecliptic intersect each other at the time of the vernal equinox; and are denoted by particular marks, according to the apparent annual motion of the sun. See fig. 158. A motion in the heavens in the order of these signs, as from Aries to Taurus, is said to be a motion *in consequence*; and such are the true motions of all the planets; tho' their apparent motions are sometimes contrary, and then they are said to move in *antecedence*. The local zodiac is not always invariably the same as to the places of the several signs, though the whole always takes up the same place in the heaven, viz. 10 degrees on each side the ecliptic. The points where the celestial equator cuts into the ecliptic are found to have a motion in antecedence of about 50 seconds in a year. This change of place of the first point of the ecliptic, from whence the signs are counted, occasions a like change in the signs themselves; which though scarce sensible for a few years, has now become very considerable. Thus, since astronomy was first cultivated among the Greeks, which is about 2000 years ago, the first point of the ecliptic is removed backward above a whole sign; and though it was then about the middle of the constellation Aries, is now about the middle of Pisces. Notwithstanding this alteration, however, the signs still retain their ancient names and marks. When the zodiac is mentioned by astronomers, the local zodiac is generally meant.

319 Longitude of celestial bodies explained.

The longitude of a phenomenon in the heavens is the number of degrees counted from the first point of Aries on the ecliptic to the place where a circle of latitude drawn through the phenomenon would cut the ecliptic at right angles. Every phenomenon in the heavens, whether in the zodiac or not, is thus referred to the ecliptic by the circles of latitude, as the longitudes of terrestrial places are referred to the equator by the meridians; and whatever sign the circle of latitude passes through, the phenomenon is said to have its place in that sign, though ever so far distant from it.

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Some astronomical writers have made the local zodiac invariable: for which purpose they imagine a circle of latitude drawn through the first star of the constellation Aries, marked in Bayer's catalogue by the Greek letter γ; and reckon their longitude from the point where that circle cuts the ecliptic. This star, from its use, is called the first star of the Ram; and when this method is made use of, the longitude of any phenomenon is said to be so many signs, degrees, minutes, &c. from the first star of the Ram. Thus, in Street's Caroline tables, the longitude of Jupiter's ascending node is two signs eight degrees from the first star of Aries, which is thus marked: Long. ♍ ☊ *à* 1 ✱ ♈ 2° 8°. The common way of reckoning the longitude of a phenemenon is to take ♈ for the first point of the ecliptic, and not to number the degrees quite round that circle as a continued series, but to make a new beginning at the first point of every sign, and to reckon from thence only the length of 30°. When this method is made use of, the longitude of any phenomenon is expressed, by saying it is in such a degree and such a minute of a sign: and thus we may express the longitude of the ascending node of Mercury, ☿ ☊ ♉ 14° 40'; and so of any other. The place of a phenomenon in the heaven is expressed by setting down its longitude and latitude as is done with places situated any where on the surface of the earth.

Having thus explained the astronomical terms commonly made use of with respect to the planets; and likewise shown how from their motions and that of the earth, there must be a considerable variation in their apparent places, as seen from the sun and from the earth; we shall now proceed to a more particular consideration of their phenomena, as derived from a composition of the two motions just mentioned, viz. that of the planets in their respective orbits, and that of the earth in the ecliptic.

320 Conjunctions and oppositions of the planets explained.

Every planet, like the moon, is sometimes in conjunction and sometimes in opposition with the sun. Its conjunction is when the geocentric place of the planet is the same with that of the sun; though an exact or central conjunction can only take place when the line of its nodes passes through the earth, and the planet itself is in one of its nodes at the time. It is however, in general, called a conjunction, or opposition, when the same circle of latitude passes through the sun and planet at the same time. When the geocentric place of a planet is 90°, or a quarter of a circle from the sun's place, the planet is said to be in *quadrature*, or in *quartile* aspect with the sun; and these terms are used in a like sense when applied to any two of the heavenly bodies. Thus the sun and moon, or the moon and any planet, or any two planets, may be in conjunction, opposition, or quadrature. Besides these, the ancients reckoned other two aspects, the *trine* and the *sextile*; the former when the bodies were distant 120°, and the latter when only half that distance. These aspects they marked thus:

321 Aspects of the planets.

Conjunction.	Opposition.	Quadrature.	Trine.	Sextile.
☌	☍	□	△	✱

The aspects were supposed to influence the affairs of mankind; and many conclusions drawn from them too absurd to be mentioned here, and now indeed almost entirely buried in oblivion. The

Fig. 158.

Aries. ♈ Taurus. ♉ Gemini. ♊

Cancer. ♋ Leo. ♌ Virgo. ♍

Libra. ♎ Scorpio. ♏ Sagittarius. ♐

Capricornus. ♑ Aquarius. ♒ Pisces. ♓

Fig. 159.

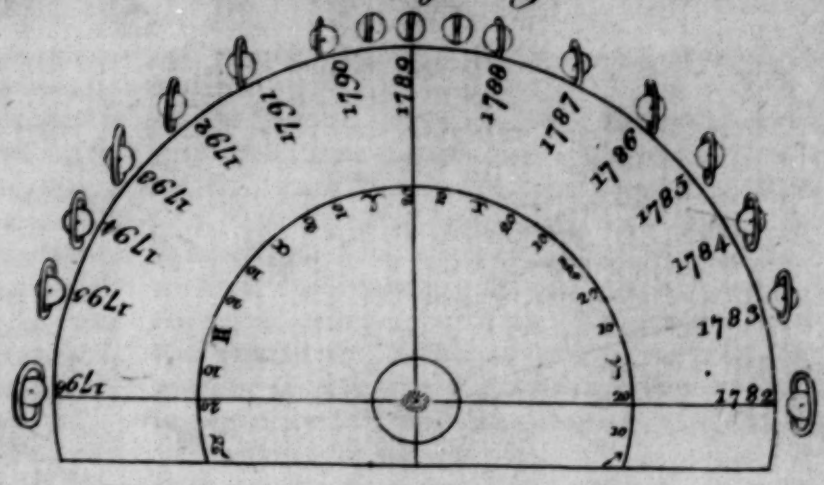


Fig. 160.

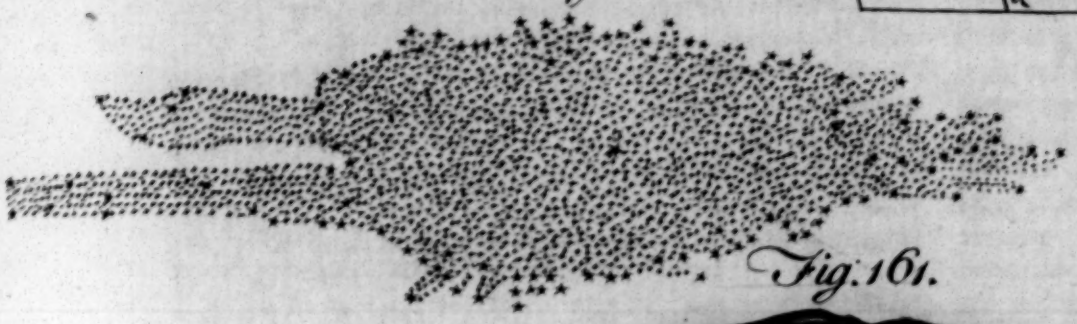
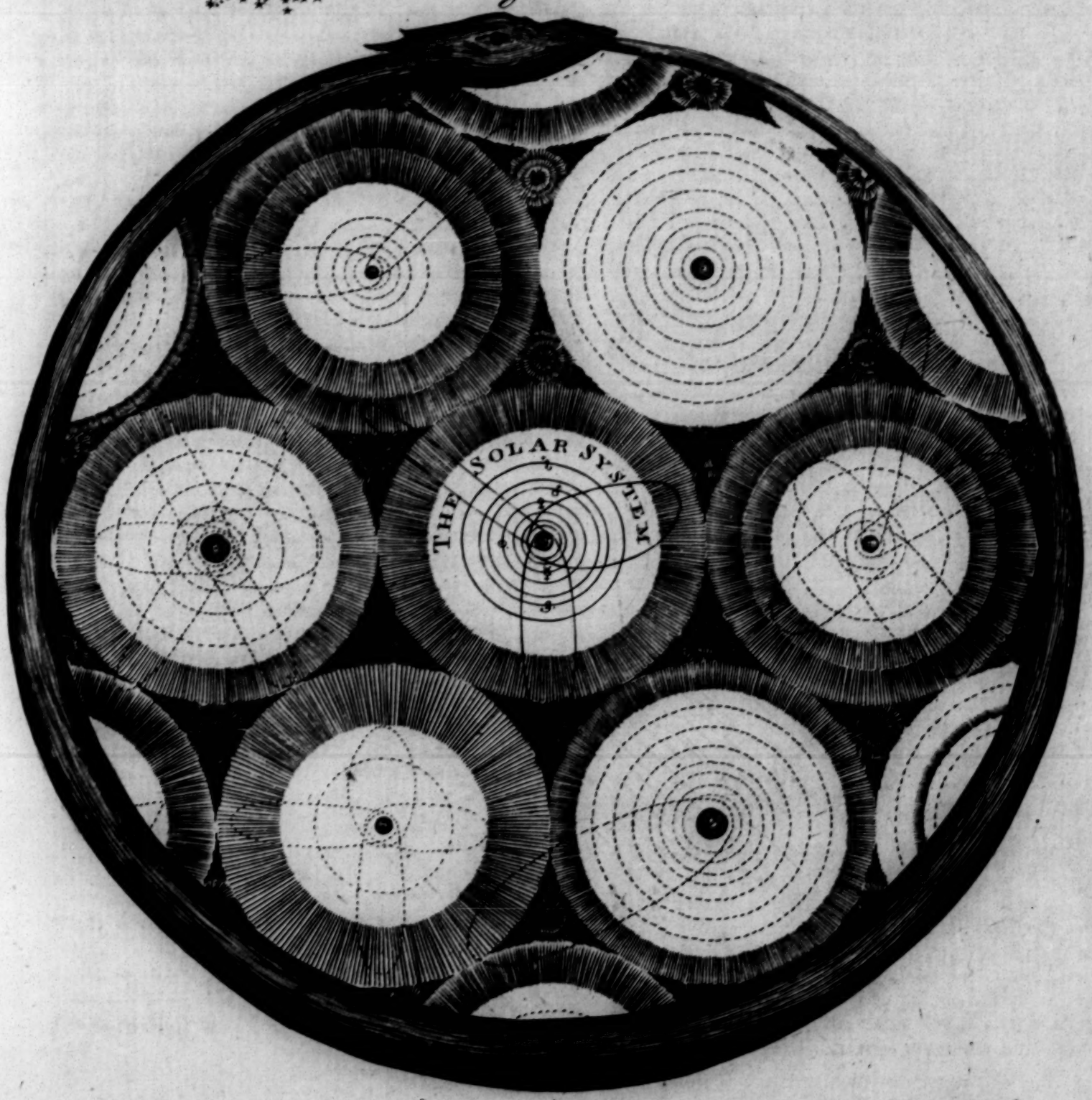


Fig. 161.



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Particular Explication of the Celeſtial Phenomena.

The inferior planets have two kinds of conjunction with the ſun; one in the inferior part of their ſemicircles, where they are nearer to the earth than the ſun; the other in the ſuperior part, where they are farther off. In the former, the planet is between the earth and the ſun; and in the latter, the ſun is between the earth and planet. The inferior planets can never be in oppoſition to the ſun, nor even appear at a great diſtance from him. The length they go is called their *elongation*. Thus, in fig. 140. let OPQRT be part of the ecliptic; S the ſun; and the three circles round him, the orbits of Mercury, Venus, and the Earth.

322 Geocentric places, &c. of the inferior planets

Suppoſe the earth to be at A, the ſun's geocentric place will be at Q. If Mercury be then at I, his geocentric place is likewiſe at Q; ſo that he is in conjunction with the ſun in his inferior ſemicircle: if at M, his geocentric place is likewiſe at Q; ſo that he is in conjunction in his ſuperior ſemicircle. In like manner, Venus at E is in conjunction in her inferior ſemicircle, at G in her ſuperior: but if we ſuppoſe the earth to be at A, and Venus at H, her geocentric place is T, and her elongation QT, which in this figure is the greateſt poſſible; for this always takes place when a ſtraight line from the earth touches the orbit of the planet, as is evident from the figure; that is, provided the planet be in its aphelion at the time. Thus the greateſt poſſible elongation of Mercury is QP when he is in his aphelion at L; and the quantity of this is found by aſtronomical obſervations to be about 28 degrees, that of Venus about 48. The inferior planets in their elongations are ſometimes eaſtward and ſometimes weſtward of the ſun: in the former caſe they appear in the evening, and in the latter in the morning. The ſmallneſs of Mercury and his nearneſs to the ſun prevent him from being often taken notice of; but the largeneſs and beauty of Venus have made her, in all ages, celebrated as the *evening* and *morning ſtar*.

323 Direct retrograde motions of the planets explained.

The irregular apparent motion of the planets has been already taken notice of; ſometimes going forward, ſometimes backward, and ſometimes appearing to ſtand ſtill for a little. Theſe different conditions are by aſtronomers called *direct*, *retrograde*, and *ſtationary*. Were they to be viewed from the ſun, they would always appear direct, as has been already ſhown; but when viewed from the earth, the inferior planets appear direct when moving in their upper ſemicircle, and retrograde when in their lower ones. Thus, in fig. 140. ſuppoſe the earth at reſt at A, while Mercury is going on in his orbit from N to I. from I to L his motion appears to an obſerver at A to be retrograde, or contrary to the order of the ſigns, namely, from R to Q and from Q to P; but when in that part of his orbit which lies between L and N, his motion appears direct, or from P to Q and from Q to R.

When the earth is in the line of nodes of an inferior planet, the apparent motion of the former is then in a ſtraight line, becauſe the plane of it paſſes through the eye; if in a conjunction in his upper ſemicircle, he paſſes behind the ſun; if in his lower ſemicircle, he paſſes before it, and will then be ſeen by an obſerver on earth to paſs over the ſun's diſk like a round and very black ſpot. Were the plane of his orbit coincident with the ecliptic, this appearance would be ſeen every year; but by reaſon of the obliquity of the two planes to each other, it is much more rare. However, he was ſeen in this manner November 12th 1782, at 3h. 44′ in the afternoon; May 4th 1786, at 6h. 57′ in the morning; and will be ſeen again December 6th 1789, at 3h. 55′ in the afternoon: but from that time not, in Britain at leaſt, until the year 1799, May 7th, at 2h. 34′ in the afternoon. In like manner, Venus ſometimes appears as a black ſpot on the ſun, but much more ſeldom than Mercury. She was firſt ſeen by Mr Horrox, as we have already related, in the year 1639; afterwards in the years 1761 and 1769; but will not afterwards be viſible in this manner till the year 1874.

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When the earth is out of the line of the nodes of an inferior planet, its orbit appears an ellipſis, more or leſs eccentric according to the ſituation of the eye of the ſpectator. Thus, ſuppoſe the earth to be as far as poſſible (that is 90°) out of the line of the nodes of Mercury, the projection of his orbit will be in ſuch an elliptic curve as is repreſented fig. 141. wherein he will appear to move in the order of the letters; direct when in his upper ſemicircle from *a* to *b*, from *b* to *c*, being above the ſun at *b* in his ſuperior conjunction: but in his inferior ſemicircle his motion will appear retrograde from *c* to *d*, and from *d* to *a*; in conjunction he will be at *d* below the ſun. In theſe caſes, the motion of Mercury is unequal; faſter near the inferior conjunction, but moſt unequal in the inferior ſemicircle, going through the unequal ſpaces into which the ellipſis is divided. The motions of the inferior planets, both direct and retrograde, are very unequal: and this inequality proceeds not from the eccentricity of their orbits, but from the projection of their orbits into long ellipſis; and is therefore a mere optical deception.

Theſe planets appear ſtationary while changing their motion from direct to retrograde, or from retrograde to direct. If the earth ſtood ſtill, the times of their appearing ſtationary would be at their greateſt elongation; for though it be a property of the circle that a ſtraight line can only touch it in one point, yet when the circle is very large the receſs from the tangent is not perceptible for a conſiderable time. Thus, in fig. 140. ſuppoſe the earth to be at reſt in A, Venus would appear ſtationary, her geocentric place continuing at T all the while ſhe is going in her orbit from *a* to *b*; becauſe her deviation from the viſual line AT would ſcarce be perceptible ſo near the point of contact H.

To an inhabitant of the earth, therefore, the inferior planets appear always near the ſun; alternately going from and returning to him, ſometimes in ſtraight lines, at others in elliptical curves, firſt on one ſide and then on the other; ſometimes ſo near as to be rendered inviſible by his ſtronger light. Sometimes, when in or near their nodes, they paſs behind the ſun in their ſuperior ſemicircles, or paſs between him and us; in which caſe they appear like black ſpots on his diſk, as has been juſt now mentioned. For the better comprehending of theſe motions, however, we have hitherto ſuppoſed the earth to ſtand ſtill in ſome part of its orbit, while they go round the ſun in theirs; but as this is not the caſe, it now remains to conſider the changes which take place in conſequence of the earth's motion. Were the earth to ſtand ſtill in any part of her

324 Effects of the earth's motion on the appearances of the planets.

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her orbit as at A, the places of conjunction both in the superior and inferior semicircle, as also of the greatest elongation; and consequently the places of direct and retrograde motion, and of the stations of an inferior planet, would always be in the same part of the heavens. Thus, in fig. 140. upon this supposition, the places of Mercury's stations would always be the points P and R, the arc of his motion PR, and of his retrograde motion RP; whereas, on account of the earth's motion, the places where these appearances happen are continually advancing forward in the ecliptic according to the order of the signs. In fig. 142, let ABCD be the orbit of the earth; *e f g h* that of Mercury; ☉ the sun; GKI an arc of the ecliptic extended to the fixed stars. When the earth is at A, the sun's geocentric place is at F; and Mercury, in order to a conjunction, must be in the line AF; that is, in his orbit he must be at *f* or *h*. Suppose him to be at *f* in his inferior semicircle: If the earth stood still at A, his next conjunction would be when he is in his superior semicircle at *h*; the places of his greatest elongation also would be at *e* and *g*, and in the ecliptic at E and G: but supposing the earth to go on in its orbit from A to B; the sun's geocentric place is now at K; and Mercury, in order to be in conjunction, ought to be in the line BK at *m*. As by the motion of the earth the places of Mercury's conjunction with the sun are thus continually carried round in the ecliptic in consequence, so the places of his utmost elongations must be carried in consequence also. Thus, when the earth is at A, the places of his greatest elongation from the sun are in the ecliptic E and G; the motion of the earth from A to B advances them forward from G to L and from E to I. But the geocentric motion of Mercury will best be seen in fig. 146. Here we have part of the extended ecliptic marked ♈, ♉, ♊, &c. in the center of which S represents the sun, and round him are the orbits of Mercury and the earth. The orbit of Mercury is divided into 11 equal parts, such as he goes through once in eight days; and the divisions are marked by numeral figures 1, 2, 3, &c. Part of the orbit of the earth is likewise divided into 22 equal arcs, each arc being as much as the earth goes through in eight days. The points of division are marked with the letters *a, b, c, d, e, f*, &c. and show as many several stations from whence Mercury may be viewed from the earth. Suppose then the planet to be at 1 and the earth at *a*; draw a line from *a* to 1, and it shews Mercury's geocentric place at A. In eight days he will be got to 2, and the earth to *b*; draw a line from 2 to *b*, and it shows his geocentric place at B. In other eight days he will have proceeded to 3, and the earth to *c*; a line drawn from 3 to *c* will show his geocentric place at C. In this manner, going through the figure, and drawing lines from the earth at *d, e, f, g*, &c. through 4, 5, 6, 7, &c. we shall find his geocentric places successively at the points D, E, F, G, &c. where we may observe, that from A to B, and from B to C, the motion is direct; from C to D, and from D to E, retrograde. In this figure 22 stations are marked in the earth's orbit, from whence the planet may be viewed; corresponding to which there ought to be as many in the orbit of Mercury: and for this purpose the place of that planet is marked at the end of every eight days for two of his periodical revolutions; and to denote this, two numeral figures are placed at each division.

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The geocentric motion of Venus may be explained in a similar manner; only as the motion of Venus is much slower than that of Mercury, his conjunctions, oppositions, elongations, and stations all return much more frequently than those of Venus.

To explain the stationary appearances of the planets, it must be remembered, that the diameter of the earth's orbit, and even that of Saturn, are but mere points in comparison of the distance of the fixed stars; and therefore, any two lines absolutely parallel, though drawn at the distance of the diameter of Saturn's orbit from each other; would, if continued to the fixed stars, appear to us to terminate in the same point. Let, then, the two circles fig. 143. represent the orbits of Venus and of the Earth; let the lines AE, BF, CG, DH, be parallel to SP, we may nevertheless affirm, that if continued to the distance of the fixed stars, they would all terminate in the same point with the line SP. Suppose then, Venus at E while the Earth is at A, the visual ray by which she is seen is the line AE. Suppose again, that while Venus goes from E to F, the Earth goes from A to B, the visual ray by which Venus is now seen is BF parallel to AE; and therefore Venus will be all that time stationary, appearing in that point of the heaven where SP extended would terminate: this station is at her changing from direct to retrograde. Again, suppose, when the Earth is at C, Venus is at G, and the visual line CG; if, while the Earth goes from C to D, Venus goes from G to H, so that she is seen in the line GH parallel to CG, she will be all that time stationary, appearing in the point where a line drawn from S through P would terminate. This station is at her changing from retrograde to direct; and both are in her inferior semicircle.

325 Perigee and apogee of the planets explained.

An inferior planet, when in conjunction with the sun in its inferior semicircle, is said to be in *perigee*, and in the other in *apogee*, on account of its different distances from the earth. Their real distances from the earth when in perigee are variable, partly owing to the eccentricities of their orbits, as well as that of the earth; and partly owing to the motions of the different bodies, by which it happens that they are in perigee in different parts of their orbits. The least possible distance is when the perigee happens when the earth is in its perihelion, and the planet in its aphelion.

326 Differences in the apparent diameters of the planets.

The difference of distance between the earth and inferior planets at different times, makes a considerable variation in their apparent diameters, which indeed is very observable in all the planets; and thus they sometimes look very considerably larger than at others. This difference in magnitude in Mercury is nearly as $5\frac{1}{4}$ to 1; and in Venus, no less than 32 to 1. A common spectator, unassisted by any instrument, may observe an inferior planet alternately approach nearer and nearer the sun, until at last it comes into conjunction with him, and then to recede farther and farther till it is at its greatest elongation, which will be first on one side and then on the other: but if we observe the apparent change of place of an inferior planet in the sphere of the heavens, its direct motions, stations, and retrogradations, measuring its diameter frequently with the micrometer,

Particular Explication of the Celestial Phenomena.

micrometer, we shall find by its decrease at some times and increase at others, that its distance from us is very considerably varied; so that, taking the whole of its course into consideration, it appears to move in a very complicated curve. See fig. 1. and C.

327 Appearances of the superior planets explained.

As the superior planets move in a larger orbit than the earth, they can only be in conjunction with the sun when they are on that side opposite to the earth; as, on the other hand, they are in opposition to him when the earth is between the sun and them. They are in quadrature with him when their geocentric places are 90° distant from that of the sun. In order to understand their apparent motions, we shall suppose them to stand still in some part of their orbit while the earth makes a complete revolution in hers; in which case, any superior planet would then have the following appearances: 1. While the earth is in her most distant semicircle, the motion of the planet will be direct. 2. While the earth is in her nearest semicircle, the planet will be retrograde. 3. While the earth is near those places of its orbit where a line drawn from the planet would be a tangent, it would appear to be stationary. Thus, in fig. 147. let *abcd* represent the orbit of the Earth; S the Sun; EFG an arc of the orbit of Jupiter; ABC an arc of the ecliptic projected on the sphere of the fixed stars. Suppose Jupiter to continue at F, while the earth goes round in her orbit according to the order of the letters *abcd*. While the earth is in the semicircle most distant from Jupiter going from *a* to *b* and from *b* to *c*, his motion in the heaven would appear direct, or from A to B and from B to C: but while the earth is in its nearest semicircle *cde*, the motion of Jupiter would appear retrograde from C to B and from B to A; for *a*, *b*, *c*, *d*, may be considered as so many different stations from whence an inhabitant of the earth would view Jupiter at different seasons of the year, and a straight line drawn from each of these stations, through F the place of Jupiter, and continued to the ecliptic, would show his apparent place there to be successively at A, B, C, B, A. While the earth is near the points of contact *a* and *c*, Jupiter would appear stationary, because the visual ray drawn through both planets does not sensibly differ from the tangent F*a* or F*c*. When the earth is at *b*, a line drawn from *b* through S and F to the ecliptic, shows Jupiter to be in conjunction with the sun at B. When the earth is at *d*, a line drawn from *d* through S, continued to the ecliptic, would terminate in a point opposite to B; which shows Jupiter then to be in opposition to the sun: and thus it appears that his motion it direct in the conjunction, but retrograde when in opposition with the sun.

The direct motion of a superior planet is swifter the nearer it is to a conjunction, and slower as it approaches to a quadrature with the sun. Thus, in fig. 144. let ⊙ be the sun; the little circle round it, the orbit of the earth, whereof *abcdefg* is the most distant semicircle: OPQ, an arc of the orbit of Jupiter; and ABCDEFG, an arc of the ecliptic in the sphere of the fixed stars. If we suppose Jupiter to stand still at P, by the earth's motion from *a* to *g*, he would appear to move direct from A to G, describing the unequal arcs AB, BC, CD, DE, EF, FG, in equal times. When the earth is at *d*, Jupiter is in conjunction with the sun at D, and there his direct motion is swiftest. When the earth is in that part of her orbit where a line drawn from Jupiter would touch it, as in the points *e* or *g*, Jupiter is nearly in quadrature with the sun; and the nearer the earth is to any of those points, the slower is the geocentric motion of Jupiter; for the arcs CD and DE are greater than BC or EF, and the arcs BC and EF are greater than AB or FG.

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The retrograde motion of a superior planet is swifter the nearer it is to an opposition, and slower as it approaches to a quadrature with the sun. Thus, let ⊙, fig. 145. be the sun; the little circle round it the orbit of the earth, whereof *ghiklmn* is the nearest semicircle; OPQ, an arc of the orbit of Jupiter; NKG an arc of the ecliptic: If we suppose Jupiter to stand still at P, by the earth's motion from *g* to *n*, he would appear to move retrograde from G to N, describing the unequal arcs GH, HI, IK, KL, LM, MN, in equal times. When the earth is at *k*, Jupiter appears at K, in opposition to the sun, and there his retrograde motion is swiftest. When the earth is either at *g* or *n*, the points of contact of the tangents P*g* and P*n*, Jupiter is nearly in quadrature with the sun: and the nearer he is to either of these points, the slower is his retrogradation, for the arcs IK and KL are greater than HI or LM; and the arcs HI and LM are greater than GH or MN. Since the direct motion is swiftest when the earth is at *d*, and continues diminishing till it changes to retrogade, it must be insensible near the time of change: and, in like manner, the retrograde motion being swiftest when the earth is in *k*, and diminishing gradually till it changes to direct, must also at the time of that change be insensible; for any motion gradually decreasing till it changes into a contrary one gradually increasing, must at the time of the change be altogether insensible.

The same changes in the apparent motions of this planet will also take place if we suppose him to go on slowly in his orbit; only they will happen every year when the earth is in different parts of her orbit, and consequently different times of the year. Thus, (fig. 147.) let us suppose, that while the earth goes round her orbit Jupiter goes from F to G, the points of the earth's orbit from which Jupiter will now appear to be stationary will be *a* and *y*; and consequently his stations must be at a time of the year different from the former. Moreover, the conjunction of Jupiter with the sun will now be when the earth is at *f*, and his opposition when it is at *e*; for which reason these also will happen at times of the year different from those of the preceding opposition and conjunction. The motion of Saturn is so slow, that it makes but little alteration either in the times or places of his conjunction or opposition; and no doubt the same will take place in a more eminent degree in the Georgium Sidus; but the motion of Mars is so much swifter than even that of Jupiter, that both the times and places of his conjunctions and oppositions are thereby very much altered.

Fig. 148. exemplifies the geocentric motion of Jupiter in a very intelligible manner: where ⊙ represents the sun; the circle 1, 2, 3 4, the orbit of the earth, divided into twelve equal arcs for the twelve months of the year; PQ an arc of the orbit of Jupiter, containing as much as he goes through in a year, and divided in in like manner into twelve equal parts each as much

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as he goes through in a month. Now, suppose the earth to be at 1 when Jupiter is at *a*, a line drawn through 1 and *a* shows Jupiter's place in the celestial ecliptic to be at A. In a month's time the earth will have moved from 1 to 2, Jupiter from *a* to *b*; and a line drawn from 2 to *b* will show his geocentric place to be in B. In another month, the earth will be in 3, and Jupiter at C, and consequently his geocentric place will be at C; and in like manner his place may be found for the other months at D, E, F, &c. It is likewise easy to observe, that his geocentric motion is direct in the arcs AB, BC, ED, DE; retrograde in EF, FG, GH, HI; and direct again in IK, KL, LM, MN. The inequality of his geocentric motion is likewise apparent from the figure.

A superior planet is in apogee when in conjunction with the sun, and in perigee when in opposition; and every one of the superior planets is at its least possible distance from the earth where it is in perigee and perihelion at the same time. Their apparent diameters are variable, according to their distances, like those of the inferior planets; and this, as might naturally be expected, is most remarkable in the planet Mars, who is nearest us. In his nearest approach, this planet is 25 times larger than when fartheſt off, Jupiter twice and a half, and Saturn once and a half.

328 Of the Georgium Sidus.

The honour of discovering the new attendant of the sun, called the *Georgium Sidus*, is undoubtedly due to Mr Herschel; though Mr Robison, professor of Natural Philosophy in Edinburgh, has given strong reasons for supposing that it had been marked by several astronomers as a fixed star. It was first observed by Mr Herschel on the 13th of March 1781, near the foot of Castor, and his attention was drawn by its steady light. On applying an higher magnifying power to his telescope, it appeared manifestly to increase in diameter; and two days after, he observed that its place was changed. From these circumstances he concluded, that it was a comet: and sent an account of it as such to the astronomer-royal, which very soon spread all over Europe. It was not long, however, before it was known, by the English astronomers especially, to be a planet.

329 How discovered to be a planet.

The circumstances which led to this discovery were, its vicinity to the ecliptic, the direction of its motion, and its being nearly stationary at the time, in such a manner as corresponds with the like appearances of the other planets. The French astronomers, however, still imagined it to be a comet, although it had not that faint train of light which usually accompanies these bodies, nor would its successive appearances correspond with such an hypothesis; so that they were at last obliged to own that it went round the sun in an orbit nearly circular.

330 Computation of its distance, &c.

Its motion was first computed on this principle by Mr Lexel professor of astronomy at St Petersburgh; who showed, that a circular orbit, whose radius is about 19 times the distance of the earth from the sun, would agree very well with all the observations which had been made during the year 1781. On the 1st of December that year it was in opposition with the sun; whence one of its stations was certainly determined. In the mean time, however, as astronomers were every where engaged in making observations on the same star, it occurred to some, that it might possibly have been observed before, though not known to be a planet. Mr Bade of Berlin, who had just published a work containing all the catalogues of zodiacal stars which had appeared, was induced, by the observations which had been already made on the new planet, to consult these catalogues, in order to discover whether any star, marked by one astronomer and omitted by another, might not be the new planet in question. In the course of this inquiry, he found, that the star, N° 964 of Mayer's catalogue, had been unobserved by others, and only once by Mr Mayer himself, so that no motion could have been perceived by him. On this Mr Bade immediately directed his telescope to that part of the heavens where he might expect to find the star marked in Mayer's catalogue, but without success. At the same time, by the calculations already made concerning the new planet, he discovered, that its apparent place in the year 1756 ought to have been that of Mayer's star, and this was one of the years in which he was busied in his observations; and on farther inquiry it was found, that the star 964 had been discovered by Mr Mayer on the 15th of September 1756: So that it is now generally believed, that the star N° 964 of Mayer's catalogue was the new planet of Herschel.

Before the end of the year 1782, it was found, that the angular motion of the planet was increasing; which showed, that it was not moving in a circle, but in an eccentric orbit, and was approaching towards the sun. Astronomers, therefore, began to investigate the inequality of this angular heliocentric motion, in order to discover the form and position of the ellipsis described. This was a very difficult task, as the small inequality of motion showed that the orbit was nearly circular, and the arch already described was no more than one-fiftieth part of the whole circumference. It was, however, by no means easy, from the variation of curvature discoverable in this small arch, to determine to what part of the circumference it belongs: though the Professor is of opinion, that the supposition of its being the star 964 of Mayer's catalogue renders the calculation easy. On this supposition, its motion has been calculated by several astronomers, as well as by Mr Robison himself. He observes, however, that if we do not admit the identity of these stars, near half a century must elapse before we can determine the elements of this planet's motion with a precision equal to that of the others.

Some astronomers are of opinion, that the new planet is the same with the star N° 34 Tauri of the Britannic catalogue. "In this case (says Mr Robison), the elements will agree very well with Flamstead's observation of that star on December 13th 1690, being only 40″, or perhaps only 12″, to the westward of it; but the latitude differs more than two minutes from Flamstead's latitude, which is properly deduced from the zenith distance. This is too great an error for him to commit in the observation; and we should therefore reject the supposition on this account alone: But there are stronger reasons for rejecting it, arising from the disagreement of those elements with the observations made on the stations of the planet in October 1781 and in March and October 1782, which give a very near approximation of its distance from the sun. When compared with observations of the planet near its stationary

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tionary points in the ſpring, they give the geocentric latitude conſiderably too great, while they give it too ſmall for the ſimilar obſervations in autumn."

331 To find the time when any planet will return into the ſame apparent ſituation.

As the times of conjunction, utmoſt elongation, direct or retrograde motions of the inferior planets, depend on the combinations of their motions in their orbits with the motion of the earth in its orbit; any of theſe appearances will be more frequent in Mercury than in Venus, becauſe the former moves with a ſwifter motion in his orbit, and conſequently muſt more frequently paſs through thoſe places where he is in conjunction, &c. The time in which any of the inferior planets will return into a given ſituation, may be known by the following examples. Let fig. 149. repreſent the orbits of Venus and the earth. Let the earth be at E, Venus at V, when ſhe is in the inferior conjunction with the ſun in ♈. From S, Venus and the earth would appear in conjunction in ♎: let Venus go round her orbit, and return to V; the earth taking longer time to go round than Venus, will, in the mean time, go from E, only through a part of her orbit, and Venus muſt overtake the earth before ſhe can have another inferior conjunction; that is, ſhe muſt, beſides an entire revolution, which is equal to four right angles, go through as much more angular motion round the ſun as the earth has done in the mean time, ſo as to be in a right line between the ſun and the earth. Suppoſe this is to happen when the earth is got to F and Venus to T, the angular motions of the earth and Venus performed in the ſame times are reciprocally as their periodical times: and therefore as the periodical time of the earth is to the periodical time of Venus; ſo is the angular motion of Venus, which is equal to four right angles, added to the angular motion of the earth, in the time between two like conjunctions of Venus, to the angular motion of the earth in the ſame time: and therefore, by diviſion of proportion, as the difference between the periodical times of Venus and the earth is to the periodical time of Venus; ſo are four right angles, or 360°, to a fourth quantity; namely, to the angular motion or number of degrees which the earth goes in her orbit from the time of one conjunction of Venus to the next conjunction of the ſame kind. Now the periodical time of the earth is 365 days 6 hours or 8766 hours; the period of Venus 224 days 16 hours or 5392 hours; the difference is 3374 hours. Say then, As 3374 is to 5392, ſo are four right angles, or 360 degrees, to a fourth number, which is 575°; which the earth goes through in a year and 218 days. Were Venus therefore this day in an inferior conjunction with the ſun, it would be a year and 218 days before ſhe come into another conjunction of the ſame kind; and this alteration in time occaſions a proportionable change in place: ſo that if one conjunction be in ♈, the next ſimilar conjunction will be in ♍. The time between any ſituation of Mercury, with regard to the ſun and the earth, and another like ſituation, may be found by the ſame method. The periodical time of the earth is 8766 hours; the period of Mercury 87 days 23 hours or 2111 hours; the difference 6655 hours. Say then, As 6655 is to 2111, ſo are four right angles or 360° to 114°, through which the earth paſſes in 116 days. If therefore Mercury were to be this day in his inferior conjunction, it would be 116 days before he were in a ſimilar ſituation.

Euc. Elm. 5. prop 17.

This problem is commonly reſolved in another manner. Aſtronomers compute the diurnal heliocentric motions of Venus and of the earth: the difference of theſe motions is the diurnal motion of Venus from the earth, or the quantity by which Venus would be ſeen to recede from the earth every day by a ſpectator placed in the ſun: thus the mean motion of Venus is every day about 59 minutes and 8 ſeconds; the difference is 37 minutes. Say, therefore, As 37 minutes is to 36°, or to 21,600 minutes, ſo is one day to the time wherein Venus, having left the earth, recedes from her 360 degrees; that is, to the time wherein ſhe returns to the earth again, or the time between two conjunctions of the ſame kind.

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332 To find the true times of the conjunctions, oppoſitions, &c. of the planets.

The times are here computed according to the mean or equable motions of the planets; and this is therefore called a mean conjunction: but becauſe Venus and the earth are really carried in elliptic orbits, in which their motions are ſometimes ſwifter and ſometimes ſlower, the true conjunctions may happen ſome days either ſooner or later than what theſe rules will give. The time of the true conjunction is to be computed from that of the mean conjunction in the following manner. Find by aſtronomical tables the places of Venus and the earth in the ecliptic, from which we ſhall have the diſtance of the two as ſeen from the ſun; compute alſo for the ſame time the triangular motions of theſe two planets for any given time, ſuppoſe ſix hours; the difference of theſe two motions will give the acceſs of Venus to the earth, or her receſs from it in ſix hours: then ſay, as this difference is to the arc between the places of Venus and the earth at the time of a mean conjunction, ſo is ſix hours to the time between the mean conjunction and the true. This time added to or ſubtracted from the time of the mean conjunction, according as Venus is in antecedence or conſequence from the earth, ſhows the time of their true conjunction.

With regard to the conjunctions, oppoſitions, direct and retrograde motions, &c. of the ſuperior planets, as they depend on the combinations of their motions with that of the earth, they will be more frequent in Saturn than in Jupiter, in Jupiter than in Mars, but moſt frequent of all in the Georgium Sidus; becauſe the ſlower the motion of the planet is, the ſooner the earth will overtake it, ſo as to have it again in any given ſituation. Thus, ſuppoſe Saturn to be in conjunction with the ſun in ♈, if he were to ſtand ſtill for one year, then he would again be in conjunction in ♈; but as he goes on ſlowly, according to the order of the ſigns, about 12° annually, the earth muſt go through almoſt 13° more than an entire revolution; ſo that there will be almoſt a year and 13 days between any conjunction between the Sun and Saturn and the conjunction immediately following. As Jupiter moves in his orbit with greater velocity than Saturn, the earth muſt have a proportionably larger ſpace added to the year; and as Mars moves ſwifter ſtill, the time betwixt any two of his conjunctions muſt be ſtill longer.

The time when a ſuperior planet will return into any given ſituation may be found by the methods al-

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ready laid down for the inferior planets. Thus, the mean diurnal motion of the earth is about 59′ 8″; the mean motion of Saturn in a day is only two minutes; the difference 57′ 8″. Say therefore, As 57′ 8″ are to 360°, or 21,600 minutes, so is one day to the space of time wherein the earth having left Saturn recedes from him 360°; that is, to the time of her return to Saturn again, or the time between two conjunctions, oppositions, or other like aspects. This time will be found 378 days, or one year and 13 days. The mean motion of Jupiter in a day is 4′ 59″; the difference between this and the earth's diurnal motion is 54′ 59″. Say then, As 54′ 59″ are to 360° or 21,600′, so is one day to the space of time when the earth, having left Jupiter, will overtake him again; which will be found to be 398 days, or one year and 33 days. The mean motion of Mars is 31′ 27″; the difference between which and the earth's diurnal motion is 27′ 41″. Say then, As 27′ 41″ are to 360° or 21,600′, so is one day to the space of time wherein the earth, having left Mars, recedes from him 360°; which will be found two years and 50 days. The true conjunctions, &c. may be found in the superior planets as in the inferior.

333 Distance, &c. of the earth.

The earth is the next planet above Venus in the system. It is 95,173,000 miles from the sun; and goes round him in 365 days 5 hours 49 minutes, from any equinox or solstice to the same again; but from any fixed star to the same again, as seen from the sun, in 365 days 6 hours 9 minutes; the former being the length of the tropical year, and the latter the length of the sidereal. It travels at the rate of 68,000 miles every hour; which motion, though upwards of 140 times swifter than that of a cannon ball, is little more than half as swift as Mecury's motion in his orbit. The earth's diameter is 7970 miles; and by turning round its axis every 24 hours from west to east, it causes an apparent diurnal motion of all the heavenly bodies from east to west. By this rapid motion of the earth on its axis, the inhabitants about the equator are carried 1042 miles every hour, whilst those on the parallel of London are carried only about 580, besides the 68,000 miles by the annual motion abovementioned, which is common to all places whatever.

That the earth is of a globular figure may be proved from several different and evident circumstances. 1. When we are at sea on board a ship, we may be out of sight of land when the land is near enough to be visible if it were not hid from our eye by the convexity of the water. Thus, let ABCD (fig. 154.) represent a portion of the globe of our earth. Let M be the top of a mountain; this cannot be seen by a person on board the ship at B, because a line drawn from M to his eye at E is intercepted by the convexity of the water, but let the ship come to C, then the mountain will be visible, because a line may be drawn from M to his eye at E. 2. The higher the eye, the further will the view be extended. It is very common for sailors from the top of the mast of a ship to discover land or ships at a much greater distance than they can do when they stand upon deck. 3. When we stand on shore, the highest part of a ship is visible at the greatest distance. If a ship is going from us out to sea, we shall continue to see the mast after the hull or body of the ship disappears, and the top of the mast will continue to be seen the longest. If a ship is coming towards us, the top of the mast comes first in view, and we see more and more till at last the hull appears. If the surface of the sea were a flat plain (fig. 155.), a line might be drawn from any object situated upon it, as the ship D, to the eye, whether placed high or low, at A or B. In this case, any object upon the earth or sea, would be visible at any distance which was not so great as to make the appearance of it too faint, or the angle under which it appears too small, to be seen by us. An object would be visible at the same distance, whether the eye were high or low. Not the highest, but the largest, objects would be visible to the greatest distance, so that we should be able to see the hulk of a ship further off than the mast: All which is contrary to experience. 4. Several navigators, such as Ferdinand Magellan, Sir Francis Drake, Captain Cook, have sailed round the globe; not in an exact circle, the land preventing them, but by going in and out as the shores happened to lie. 5. All the appearances in the heavens are the same, whether at land or sea. 6. Eclipses of the moon arise from the shadow of the earth, and this shadow is always circular. Although the earth presents, during several hours, different portions of its surface to the moon, yet still the shadow is round. The small inequalities upon the surface of the earth bear no kind of proportion to its magnitude sufficient to alter the appearance of its shadow.

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The earth's axis makes an angle of 23½ degrees with the axis of its orbit, and keeps always the same oblique direction, inclining nearly to the same fixed stars (A) throughout its annual course, which causes the returns of spring, summer, autumn, and winter.

334 Demonstration of the earth's motion.

That the sun, and not the earth, is the centre of our solar system, may be demonstrated beyond a possibility of doubt, from considering the forces of gravitation and projection, by which all the celestial bodies are retained in their orbits. For, if the sun moves about the earth, the earth's attractive power must draw the sun towards it from the line of projection so as to bend its motion into a curve: But the sun being at least 227,000 times as heavy as the earth, by being so much weightier as its quantity of matter is greater, it must move 227,000 times as slowly towards the earth as the earth does towards the sun; and consequently the earth would fall to the sun in a short time, if it had not a very strong projectile motion to carry it off. The earth, therefore, as well as every other planet in the system, must have a rectilineal impulse, to prevent its falling into the sun. To say, that gravitation retains

(A) This is not strictly true, as will appear when we come to treat of the recession of the equinoctial points in the heavens, which recession is equal to the deviation of the earth's axis from its parallelism: but this is rather too small to be sensible in an age, except to those who make very nice observations.

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tains all the other planets in their orbits without affecting the earth, which is placed between the orbits of Mars and Venus, is as abſurd as to ſuppoſe that ſix cannon-bullets might be projected upwards to different heights in the air, and that five of them ſhould fall down to the ground; but the ſixth, which is neither the higheſt nor the loweſt, ſhould remain ſuſpended in the air without falling, and the earth move round about it.

There is no ſuch thing in nature as a heavy body moving round a light one as its center of motion. A pebble faſtened to a mill-ſtone by a ſtring, may by an eaſy impulſe be made to circulate round the mill-ſtone: but no impulſe can make a mill-ſtone circulate round a looſe pebble; for the mill-ſtone would go off, and carry the pebble along with it.

The ſun is ſo immenſely bigger and heavier than the earth, that, if he was moved out of his place, not only the earth, but all the other planets, if they were united into one maſs, would be carried along with the ſun as the pebble would be with the mill-ſtone.

335 From the proportional decreaſe of gravity, &c.

By conſidering the law of gravitation, which takes place throughout the ſolar ſyſtem, in another light, it will be evident that the earth moves round the ſun in a year, and not the ſun round the earth. It has been obſerved, that the power of gravity decreaſes as the ſquare of the diſtance increaſes; and from this it follows with mathematical certainty, that when two or more bodies move round another as their centre of motion, the ſquares of their periodic times would be to one another in the ſame proportion as the cubes of their diſtances from the central body. This holds preciſely with regard to the planets round the ſun, and the ſatellites round the planets; the relative diſtances of all which are well known. But, if we ſuppoſe the ſun to move round the earth, and compare its period with the moon's by the above rule, it will be found that the ſun would take no leſs than 173,510 days to move round the earth; in which caſe our year would be 475 times as long as it now is. To this we may add, that the aſpects of increaſe and decreaſe of the planets, the times of their ſeeming to ſtand ſtill, and to move direct and retrograde, anſwer preciſely to the earth's motion, but not at all to the ſun's, without introducing the moſt abſurd and monſtrous ſuppoſitions, which would deſtroy all harmony, order, and ſimplicity, in the ſyſtem. Moreover, if the earth be ſuppoſed to ſtand ſtill, and the ſtars to revolve in free ſpaces about the earth in 24 hours, it is certain that the forces by which the ſtars revolve in their orbits are not directed to the earth, but to the centres of the ſeveral orbits, that is, of the ſeveral parallel circles which the ſtars on different ſides of the equator deſcribe every day: and the like inferences may be drawn from the ſuppoſed diurnal motion of the planets, ſince they are never in the equinoctial but twice, in their courſes with regard to the ſtarry heavens. But, that forces ſhould be directed to no central body, on which they phyſically depend, but to innumerable imaginary points in the axis of the earth produced to the poles of the heavens, is an hypotheſis too abſurd to be allowed of by any rational creature. And it is ſtill more abſurd to imagine, that theſe forces ſhould increaſe exactly in proportion to the diſtances from this axis; for this is an indication of an increaſe to infinity; whereas the force of attraction is found to decreaſe in receding from the fountain from whence it flows. But the farther any ſtar is from the quieſcent pole, the greater muſt be the orbit which it deſcribes; and yet it appears to go round in the ſame time as the neareſt ſtar to the pole does. And if we take into conſideration the twofold motion obſerved in the ſtars, one diurnal round the axis of the earth in 24 hours, and the other round the axis of the ecliptic in 25,920 years, it would require an explication of ſuch a perplexed compoſition of forces, as could by no means be reconciled with any phyſical theory.

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336 Objection againſt the earth's motion anſwered.

The ſtrongeſt objection that can be made againſt the earth's motion round the ſun is, that in oppoſite points of the earth's orbit, its axis, which always keeps a parallel direction, would point to different fixed ſtars; which is not found to be fact. But this objection is eaſily removed, by conſidering the immenſe diſtance of the ſtars in reſpect of the diameter of the earth's orbit; the latter being no more than a point when compared to the former. If we lay a ruler on the ſide of a table, and along the edge of the ruler view the top of a ſpire at ten miles diſtance; then lay the ruler on the oppoſite ſide of the table, in a parallel ſituation to what it had before, and the ſpire will ſtill appear along the edge of the rule; becauſe our eyes, even when aſſiſted by the beſt inſtruments, are incapable of diſtinguiſhing ſo ſmall a change at ſo great a diſtance.

337 Earth's motion demonſtrated from the aberration of light.

Dr Bradley, our late aſtronomer-royal, found by a long ſeries of the moſt accurate obſervations, that there is a ſmall apparent motion of the fixed ſtars, occaſioned by the aberration of their light; and ſo exactly anſwering to an annual motion of the earth, as evinces the ſame, even to a mathematical demonſtration. He conſidered this matter in the following manner: he imagined CA, fig. 33. to be a ray of light falling perpendicularly upon the line BD; that if the eye is at reſt at A, the object muſt appear in the direction AC, whether light be propagated in time or in an inſtant. But if the eye is moving from B towards A, and light is propagated in time, with a velocity that is to the velocity of the eye, as CA to BA; then light moving from C to A, whilſt the eye moves from B to A, that particle of it by which the object will be diſcerned when the eye comes to A, is at C when the eye is at B. Joining the points BC, he ſuppoſed the line CB to be a tube, inclined to the line BD in the angle DBC, of ſuch diameter as to admit but one particle of light. Then it was eaſy to conceive, that the particle of light at C, by which the object muſt be ſeen, when the eye, as it moves along, arrives at A, would paſs through the tube BC, if it is inclined to BD in the the angle BDC, and accompanies the eye in its motion from B to A; and that it could not come to the eye placed behind ſuch a tube, if it had any other inclination to the line BD. If, inſtead of ſuppoſing CB ſo ſmall a tube, we imagine it to be the axis of a larger; then, for the ſame reaſon, the particle of light at C would not paſs through the axis, unleſs it is inclined to BD in the angle CBD. In like manner, if the eye moved the contrary way, from D towards A, with the ſame velocity, then the tube muſt be inclined in the angle BCD. Although, therefore, the true or real place of an object is perpendicular to the line in which the eye is moving, yet the viſible place will not be ſo; ſince that, no doubt, muſt be in the direction of the

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tube; but the difference between the true and apparent place will be *cæteris paribus*, greater or leſs, according to the different proportion between the velocity of light and that of the eye. So that, if we could ſuppoſe that light was propagated in an inſtant, then there would be no difference between the real and viſible place of an object, although the eye was in motion: for in that caſe, AC being infinite with reſpect to AB, the angle ACB, the difference between the true and viſible place, vaniſhes. But if light be propagated in time, it is evident, from the foregoing conſiderations, that there will be always a difference between the real and viſible place of an object, unleſs the eye is moving either directly towards or from the object. And in all caſes the ſine of the difference between the real and viſible place of the object will be to the ſine of the viſible inclination of the object to the line in which the eye is moving, as the velocity of eye is to the velocity of light.

He then ſhows, that if the earth revolve round the ſun annually, and the velocity of light be to the velocity of the earth's motion in its orbit, as 1000 to 1, that a ſtar really placed in the very pole of the ecliptic would, to an eye carried along with the earth, ſeem to change its place continually; and, neglecting the ſmall difference on the account of the earth's diurnal revolution on its axis, would ſeem to deſcribe a circle round that pole every way diſtant from it $3\frac{1}{2}$; ſo that its longitude would be varied through all the points of the ecliptic every year, but its latitude would always remain the ſame. Its right aſcenſion would alſo change, and its declination, according to the different ſituation of the ſun with reſpect to the equinoctial points, and its apparent diſtance from the north pole of the equator, would be 7′ leſs at the autumnal than at the vernal equinox.

338 Velocity of light. By calculating exactly the quantity of abberration of the fixed ſtars from their place, he found that light came from the ſun to us in 8′ 13″; ſo that its velocity is to the velocity of the earth in its orbit as 10,201 to 1.

339 Errors in the obſervation of ſmall angles. It muſt here be taken notice of, however, that Mr Nevil Maſkelyne, in attempting to find the parallax of Sirius, with a ten-feet ſector, obſerved that by the friction of the plummet line on the pin which ſuſpended it, and error of 10″, 20″, and ſometimes 30″, was committed. The pin was $\frac{1}{4}$ of an inch diameter; and though he reduced it to $\frac{1}{8}$ of an inch, the error ſtill amounted to 3″. All obſervations, therefore, that have hitherto been made in order to diſcover the parallax of the fixed ſtars, are to be diſregarded.

340 Another objection againſt the earth's motion anſwered. It is alſo objected, that the ſun ſeems to change his place daily, ſo as to make a tour round the ſtary heavens in a year. But whether the ſun or earth moves, this appearance will be the ſame, for when the earth is in any part of the heavens, the ſun will appear in the oppoſite. And therefore, this appearance can be no objection againſt the motion of the earth.

It is well known to every perſon who has ſailed on ſmooth water, or been carried by a ſtream in a calm, that, however faſt the veſſel goes, he does not feel its progreſſive motion. The motion of the earth is incomparably more ſmooth and uniform than that of a ſhip, or any machine made and moved by human art; and therefore it is not to be imagined that we can feel its motion.

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We find that the ſun, and thoſe planets on which there are viſible ſpots, turn round their axis: for the ſpots move regularly over their diſks (B.) From hence we may reaſonably conclude, that the other planets on which we ſee no ſpots, and the earth, which is likewiſe a planet, have ſuch rotations. But being incapable of leaving the earth, and viewing it at a diſtance, and its rotation being ſmooth and uniform, we can neither ſee it move on its axis as we do the planets, nor feel ourſelves affected by its motion. Yet there is one effect of ſuch a motion, which will enable us to judge with certainty whether the earth revolves on its axis or not. All globes which do not turn round their axis will be perfect ſpheres, on account of the equality of the weight of bodies on their ſurfaces; eſpecially of the fluid parts. But all globes which turn on their axes will be oblate ſpheroids; that is, their ſurfaces will be higher or farther from the centre in the equatorial than in the polar regions: for as the equatorial parts move quickeſt, they will recede fartheſt from the axis of motion, and enlarge the equatorial diameter. That our earth is really of this figure, is demonſtrable from the unequal vibrations of a pendulum, and the unequal lengths of degrees in different latitudes. Since then the earth is higher at the equator than at the poles, the ſea, which naturally runs downward, or toward the places which are neareſt the centre, would run towards the polar regions, and leave the equatorial parts dry, if the centrifugal force of theſe parts, by which the waters were carried thither, did not keep them from returning. The earth's equatorial diameter is 36 miles longer than its axis.

341 Argument for the earth's motion from its ſpheroidal figure.

342 Weight of bodies increaſes towards the poles. Bodies near the poles are heavier than thoſe towards the equator, becauſe they are nearer the earth's centre, where the whole force of the earth's attraction is accumulated. They are alſo heavier, becauſe their centrifugal force is leſs, on account of their diurnal motion being ſlower. For both theſe reaſons, bodies carried from the poles toward the equator gradually loſe their weight. Experiments prove, that a pendulum which vibrates ſeconds near the poles vibrates ſlower near the equator, which ſhows that it is lighter or leſs attracted there. To make it oſcillate in the ſame time, it is found neceſſary to diminiſh its length. By comparing the different lengths of pendulums ſwinging ſeconds at the equator and at London, it is found that a pendulum muſt be $2\frac{4}{1000}$ lines ſhorter at the equator than at the poles. A line is a twelfth part of an inch.

If the earth turned round its axis in 84 minutes 43 ſeconds, the centrifugal force would be equal to the power of gravity at the equator: and all bodies there would entirely loſe their weight. If the earth revolved quicker, they would all fly off and leave it.

A perſon on the earth can no more be ſenſible of its undiſturbed motion on its axis, than one in the cabbin of

(B.) This, however, muſt be underſtood with ſome degree of limitation, as will evidently appear from what has been already ſaid concerning the variable motion both of the ſpots of the ſun and planets.

Fig 162

Irregularities of the Moons Motion.

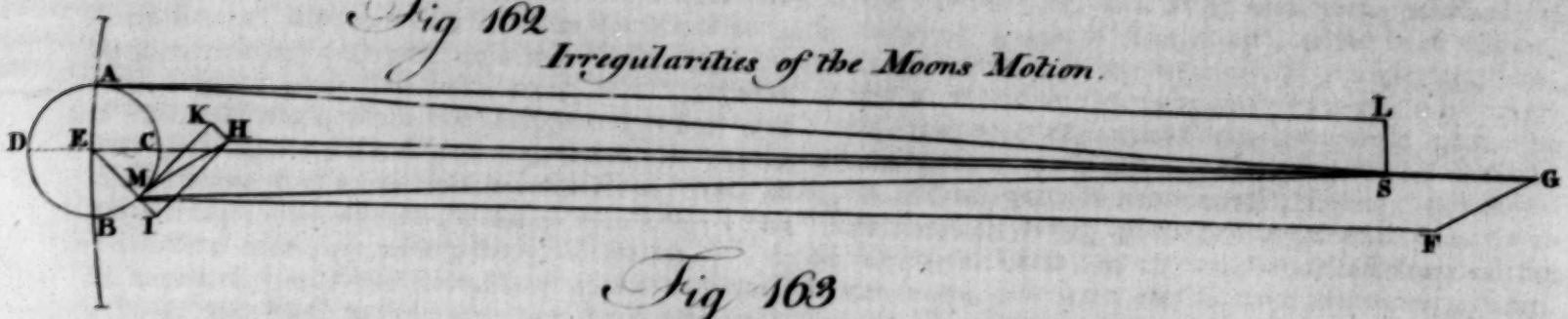


Fig 163

Irregularities of the Moons Motion.

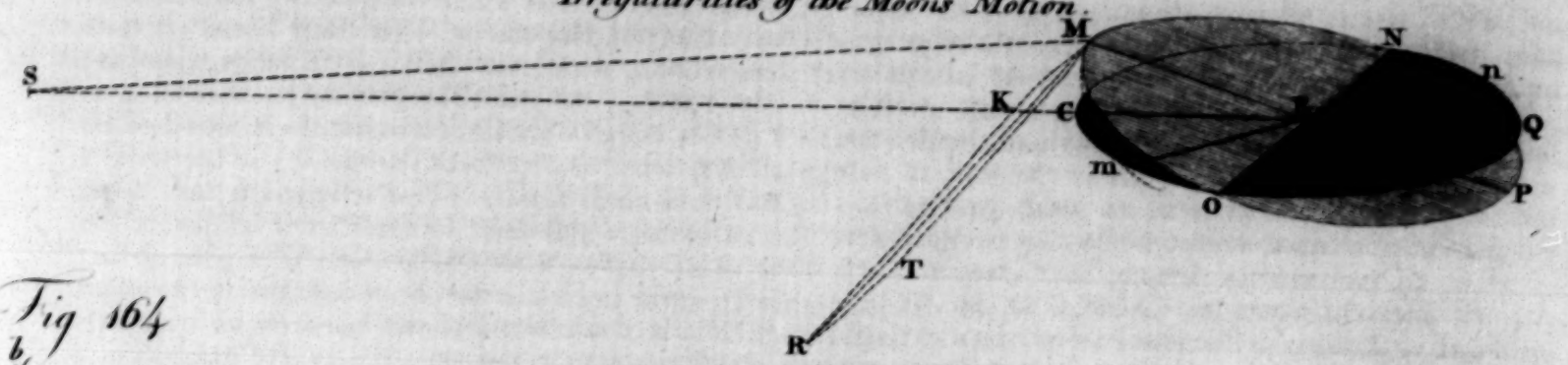


Fig 164

AZIMUTH Compafs

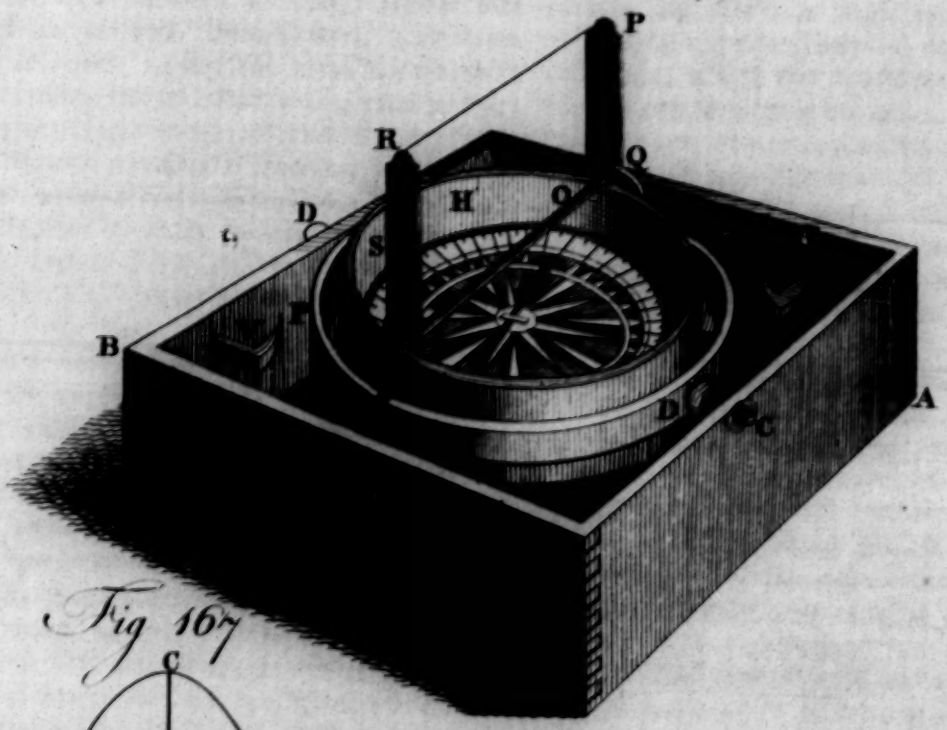


Fig 165

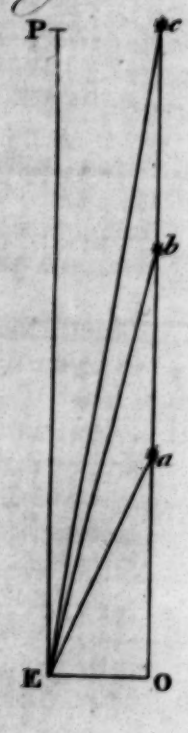


Fig 166

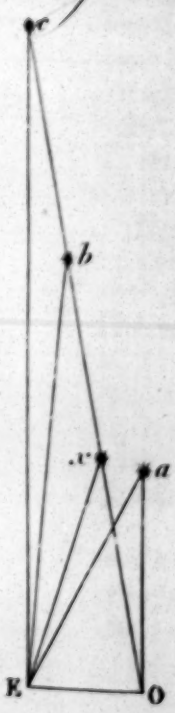


Fig 167

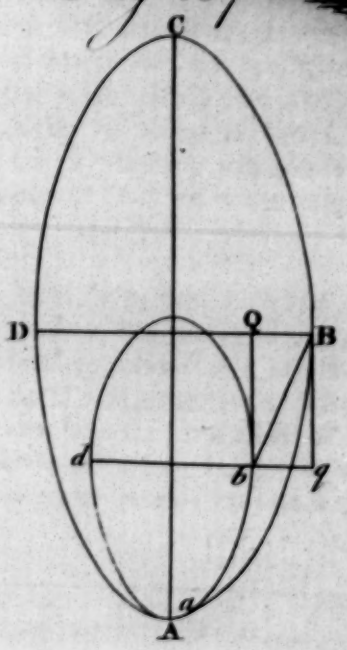


Fig 168

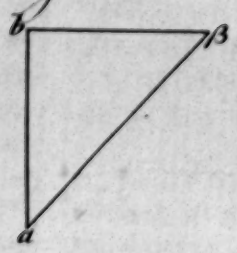
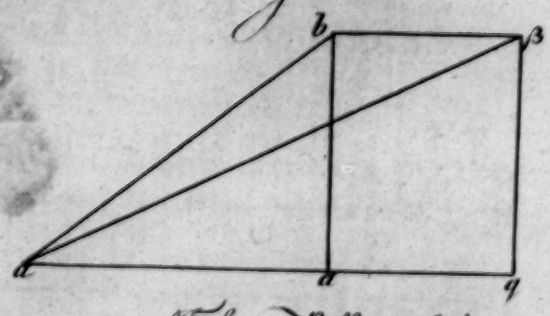


Fig 169



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of a ſhip on ſmooth water can be ſenſible of the ſhip's motion when it turns gently and uniformly round. It is therefore no argument againſt the earth's diurnal motion, that we do not feel it: nor is the apparent revolutions of the celeſtial bodies every day a proof of the reality of theſe motions; for whether we or they revolve, the appearance is the very ſame. A perſon looking through the cabin-windows of a ſhip, as ſtrongly fancies the objects on land to go round when the ſhip turns as if they were actually in motion.

343 Earth's motion proved from the celeſtial appearances from different planets.

If we could tranſlate ourſelves from planet to planet, we ſhould ſtill find that the ſtars would appear of the ſame magnitudes, and at the ſame diſtances from each other, as they do to us here; becauſe the width of the remoteſt planet's orbit bears no ſenſible proportion to the diſtance of the ſtars. But then the heavens would ſeem to revolve about very different axes; and conſequently, thoſe quieſcent points, which are our poles in the heavens, would ſeem to revolve about other points, which, though apparently in motion as ſeen from the earth, would be at reſt as ſeen from any other planet. Thus the axis of Venus, which lies at right angles to the axis of the earth, would have its motionleſs poles in two oppoſite points of the heavens lying almoſt in our equinoctial, where the motion appears quickeſt, becauſe it is ſeemingly performed in the greateſt circle: and the very poles, which are at reſt to us, have the quickeſt motion of all as ſeen from Venus. To Mars and Jupiter the heavens appear to turn round with very different velocities on the ſame axis, whoſe poles are about 23½ degrees from ours. Were we on Jupiter, we ſhould be at firſt amazed at the rapid motion of the heavens; the ſun and ſtars going round in 9 hours 56 minutes. Could we go from thence to Venus, we ſhould be as much ſurpriſed at the ſlowneſs of the heavenly motions; the ſun going but once round in 584 hours, and the ſtars in 540. And could we go from Venus to the moon, we ſhould ſee the heavens turn round with a yet ſlower motion; the ſun in 708 hours, the ſtars in 655. As it is impoſſible theſe various circumvolutions in ſuch different times, and on ſuch different axes, can be real, ſo it is unreaſonable to ſuppoſe the heavens to revolve about our earth more than it does about any other planet. When we reflect on the vaſt diſtance of the fixed ſtars, to which 190,000,000 of miles, the diameter of the earth's orbit, is but a point, we are filled with amazement at the immenſity of their diſtance. But if we try to frame an idea of the extreme rapidity with which the ſtars muſt move, if they move round the earth in 24 hours, the thought becomes ſo much too big for our imagination, that we can no more conceive it than we do infinity or eternity. If the ſun was to go round the earth in 24 hours, he muſt travel upwards of 300,000 miles in a minute: but the ſtars being at leaſt 400,000 times as far from the ſun as the ſun is from us, thoſe about the equator muſt move 400,000 times as quick. And all this to ſerve no other purpoſe than what can be as fully and much more ſimply obtained by the earth's turning round eaſtward, as on an axis, every 24 hours, cauſing thereby an apparent diurnal motion of the ſun weſtward, and bringing about the alternate returns of day and night.

344 Another objection anſwered.

As to the common objections againſt the earth's motion on its axis, they are all eaſily anſwered and ſet aſide. That it may turn without being ſeen or felt by us to do ſo, has been already ſhown. But ſome are apt to imagine, that if the earth turns eaſtward (as it certainly does if it turns at all), a ball fired perpendicularly upward in the air muſt fall conſiderably weſtward of the place it was projected from. The objection, which at firſt ſeems to have ſome weight, will be found to have none at all, when we conſider that the gun and ball partake of the earth's motion; and therefore the ball being carried forward with the air as quick as the earth and air turn, muſt fall down on the ſame place. A ſtone let fall from the top of a mainmaſt, if it meets with no obſtacle, falls on the deck as near the foot of the maſt when the ſhip ſails as when it does not. If an inverted bottle full of liquor be hung up to the ceiling of the cabin, and a ſmall hole be made in the cork to let the liquor drop through on the floor, the drops will fall juſt as far forward on the floor when the ſhip ſails as when it is at reſt. And gnats or flies can as eaſily dance among one another in a moving cabin as in a fixed chamber. As for thoſe ſcripture expreſſions which ſeem to contradict the earth's motion, this general anſwer may be made to them all, viz. It is plain from many inſtances, that the ſcriptures were never intended to inſtruct us in philoſophy or aſtronomy; and therefore on thoſe ſubjects expreſſions are not always to be be taken in the literal ſenſe, but for the moſt part as accommodated to the common apprehenſions of mankind. Men of ſenſe in all ages, when not treating of the ſciences purpoſely, have followed this method: and it would be in vain to follow any other in addreſſing ourſelves to the vulgar, or bulk of any community.

345 Diurnal motion of the earth, and different changes of the ſeaſons, illuſtrated by experiment Fig. 172.

The following experiment will give a plain idea of the diurnal or annual motions of the earth, together with the different lengths of days and nights, and all the beautiful variety of ſeaſons, depending on thoſe motions.

Take about ſeven feet of ſtrong wire, and bend it into a circular form, as a b c d, which being viewed obliquely, appears elliptical, as in the figure. Place a lighted candle on a table; and having fixed one end of a ſilk thread K to the north pole of a ſmall terreſtrial globe H, about three inches diameter, cauſe another perſon to hold the wire circle, ſo that it may be parallel to the table, and as high as the flame of the candle I, which ſhould be in or near the centre. Then having twiſted the thread as towards the left hand, that by untwiſting it may turn the globe round eaſtward, or contrary to the way that the hands of a watch move, hang the globe by the thread within this circle, almoſt contiguous to it; and as the thread untwiſts, the globe (which is enlightened half round by the candle as the earth is by the ſun) will turn round its axis, and the different places upon it will be carried through the light and dark hemiſpheres, and have the appearance of a regular ſucceſſion of days and nights, as our earth has in reality by ſuch a motion. As the globe turns, move your hand ſlowly, ſo as to carry the globe round the candle according to the order of the letters a b c d, keeping its centre even with the wire circle; and you will perceive, that the candle, being ſtill perpendicular to the equator, will enlighten the globe from pole to pole in its whole motion round the circle; and that every place on the globe goes equally through the light and the dark, as it turns round by the untwiſting

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ing of the thread, and therefore has a perpetual equinox. The globe thus turning round represents the earth turning round its axis; and the motion of the globe round the candle represents the earth's annual motion round the sun; and shows, that if the earth's orbit had no inclination to its axis, all the days and nights of the year would be equally long, and there would be no different seasons. Hence also it appears why the planets Mars and Jupiter have a perpetual equinox, namely, because their axes are perpendicular to the planes of their orbits, as the thread round which the globe turns in this experiment is perpendicular to the plane of the area inclosed by the wire.—But now desire the person who holds the wire to hold it obliquely in the position ABCD, raising the side ♋ just as much as he depresses the side ♑, that the flame may be still in the plane of the circle; and twisting the thread as before, that the globe may turn round its axis the same way as you carry it round the candle; that is, from west to east; let the globe down into the lowermost part of the wire circle at ♑: and if the circle be properly inclined, the candle will shine perpendicularly on the tropic of Cancer; and the frigid zone, lying within the arctic or north polar circle, will be all in the light, as in the figure: and will keep in the light let the globe turn round its axis ever so often. From the equator to the north polar circle, all the places have longer days and shorter nights; but from the equator to the south polar circle, just the reverse. The sun does not set to any part of the north frigid zone, as shown by the candle's shining on it, so that the motion of the globe can carry no place of that zone into the dark; and at the same time the south frigid zone is involved in darkness, and the turning of the globe brings none of its places into the light. If the earth were to continue in the like part of its orbit, the sun would never set to the inhabitants of the north frigid zone, nor rise to those of the south. At the equator, it would be always equal day and night; and as places are gradually more and more distant from the equator towards the arctic circle, they would have longer days and shorter nights; whilst those on the south side of the equator would have their nights longer than their days. In this case, there would be continual summer on the north side of the equator, and continual winter on the south side of it.

But as the globe turns round its axis, move your hand slowly forward, so as to carry the globe from H towards E, and the boundary of light and darkness will approach towards the north pole, and recede towards the south pole; the northern places will go through less and less of the light, and the southern places through more and more of it; showing how the northern days decrease in length and the southern days increase, whilst the globe proceeds from H to E. When the globe is at E, it is at a mean state between the lowest and highest parts of its orbit; the candle is directly over the equator, the boundary of light and darkness just reaches to both the poles, and all places on the globe go equally through the light and dark hemispheres, showing that the days and nights are then equal to all places of the earth, the poles only excepted; for the sun is then setting to the north pole and rising to the south pole.

Continue moving the globe forward, and as it goes through the quarter A, the north pole recedes still farther into the dark hemisphere, and the south pole advances more into the light, as the globe comes nearer to ♋: and when it comes there at F, the candle is directly over the tropic of Capricorn; the days are at the shortest and nights at the longest, in the northern hemisphere, all the way from the equator to the arctic circle; and the reverse in the southern hemisphere from the equator to the antarctic circle; within which circles it is dark to the north frigid zone and light to the south.

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Continue both motions; and as the globe moves through the quarter B, the north pole advances towards the light, and the south pole recedes towards the dark; the days lengthen in the northern hemisphere and shorten in the southern; and when the globe comes to G, the candle will be again over the equator (as when the globe was at E), and the days and nights will again be equal as formerly; and the north pole will be just coming into the light, the south pole going out of it.

Thus we see the reason why the days lengthen and shorten from the equator to the polar circles every year; why there is sometimes no day or night for many turnings of the earth, within the polar circles; why there is but one day and one night in the whole year at the poles; and why the days and nights are equally long all the year round at the equator, which is always equally cut by the circle bounding light and darkness.

The inclination of an axis or orbit is merely relative, because we compare it with some other axis or orbit which we consider as not inclined at all. Thus, our horizon being level to us, whatever place of the earth we are upon, we consider it as having no inclination; and yet, if we travel 90 degrees from that place, we shall then have an horizon perpendicular to the former; but it will still be level to us.

346 Different seasons particularly explained.

Let us now take a view of the earth in its annual course round the sun, considering its orbit as having no inclination; and its axis as inclining 23½ degrees from a line perpendicular to the plane of its orbit, and keeping the same oblique direction in all parts of its annual course; or, as commonly termed, keeping always parallel to itself.

Let *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, be the earth in eight different parts of its orbit, equidistant from one another; N*s* its axis, N its north pole, *s* its south pole, and S the sun nearly in the centre of the earth's orbit. As the earth goes round the sun according to the order of the letters *abcd*, &c. its axis N*s* keeps the same obliquity, and is still parallel to the line MN*s*. When the earth is at *a*, its north pole inclines towards the sun S, and brings all the northern places more into the light than at any other time of the year. But when the earth is at *e* in the opposite time of the year, the north pole declines from the sun, which occasions the northern places to be more in the dark than in the light, and the reverse at the southern places; as is evident by the figure which is taken from Dr Long's astronomy. When the earth is either at *c* or *g*, its axis inclines not either to or from the sun, but lies sidewise to him, and then the poles are in the boundary of light and darkness; and the sun, being directly over the equator, makes equal day and night at all places. Fig. 174.

When

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When the earth is at *b*, it is half-way between the ſummer ſolſtice and harveſt equinox; when it is at *d*, it is half-way from the harveſt equinox to the winter ſolſtice; at *f*, half-way from the winter ſolſtice to the ſpring equinox; and at *h*, half-way from the ſpring equinox to the ſummer ſolſtice.

From this oblique view of the earth's orbit, let us ſuppoſe ourſelves to be raiſed far above it, and placed juſt over its centre S, looking down upon it from its north pole; and as the earth's orbit differs but very little from a circle, we ſhall have its figure in ſuch a view repreſented by the circle ABCDEFG. Let us ſuppoſe this circle to be divided into 12 equal parts, called *ſigns*, having their names affixed to them; and each ſign into 30 equal parts, called *degrees*, numbered 10, 20, 30, as in the outermoſt circle of the figure, which repreſents the great ecliptic in the heavens. The earth is ſhown in eight different poſitions in this circle; and in each poſition Æ is the equator, T the tropic of Cancer, the dotted circle the parallel of London, U the arctic or north polar circle, and P the north pole, where all the meridians or hour-circles meet. As the earth goes round the ſun, the north pole keeps conſtantly towards one part of the heavens, as it keeps in the figure towards the right-hand ſide of the plate.

Fig. 177.

When the earth is at the beginning of Libra, namely on the 20th of March, in this figure the ſun S as ſeen from the earth, appears at the beginning of Aries in the oppoſite part of the heavens, the north pole is juſt coming into the light, and the ſun is vertical to the equator; which, together with the tropic of Cancer, parallel of London, and arctic circle, are all equally cut by the circle bounding light and darkneſs, coinciding with the ſix-o'clock hour-circle, and therefore the days and nights are equally long at all places: for every part of the meridian ÆTL*a* comes into the light at ſix in the morning, and, revolving with the earth according to the order of the hour-letters, goes into the dark at ſix in the evening. There are 24 meridians or hour-circles drawn on the earth in this figure, to ſhow the time of ſun-riſing and ſetting at different ſeaſons of the year.

As the earth moves in the ecliptic according to the order of the letters ABCD, &c. through the ſigns Libra, Scorpio, and Sagittarius, the north pole P comes more and more into the light; the days increaſe as the nights decreaſe in length, at all places north of the equator Æ; which is plain by viewing the earth at *b* on the 5th of May, when it is in the 15th degree of Scorpio, and the ſun as ſeen from the earth appears in the 15th degree of Taurus. For then the tropic of Cancer T is in the light from a little after five in the morning till almoſt ſeven in the evening; the parallel of London, from half an hour paſt four till half an hour paſt ſeven; the polar circle U, from three till nine; and a large track round the north pole P has day all the 24 hours, for many rotations of the earth on its axis.

When the earth comes to *e* (fig. 174.) at the beginning of Capricorn, and the ſun as ſeen from the earth appears at the beginning of Cancer, on the 21ſt of June, as in this figure, it is in the poſition C in fig. 177; and its north pole inclines towards the ſun, ſo as to bring all the north frigid zone into the light, and the northern parallels of latitude more into the light than the dark from the equator to the polar circle; and the more ſo as they are farther from the equator. The tropic of Cancer is in the light from five in the morning till ſeven at night, the parallel of London from a quarter before four till a quarter after eight; and the polar circle juſt touches the dark, ſo that the ſun has only the lower half of his diſk hid from the inhabitants on that circle for a few minutes about midnight, ſuppoſing no inequalities in the horizon, and no refractions.

Particular Explication of the Celeſtial Phenomena.

A bare view of the figure is enough to ſhow, that as the earth advances from Capricorn towards Aries, and the ſun appears to move from Cancer towards Libra, the north pole recedes from the light, which cauſes the days to decreaſe and the nights to increaſe in length, till the earth comes to the beginning of Aries, and then they are equal as before; for the boundary of light and darkneſs cuts the equator and all its parallels equally, or in halves. The north pole then goes into the dark, and continues therein until the earth goes halfway round its orbit; or, from the 23d of September till the 20th of March. In the middle between theſe times, viz. on the 22d of December, the north pole is as far as it can be in the dark, which is 23½ degrees, equal to the inclination of the earth's axis from a perpendicular to its orbit: and then the northern parallels are as much in the dark as they were in the light on the 21ſt of June; the winter nights being as long as the ſummer days, and the winter days as ſhort as the ſummer nights. Here it muſt be noted, that of all that has been ſaid of the northern hemiſphere, the contrary muſt be underſtood of the ſouthern; for on different ſides of the equator the ſeaſons are contrary, becauſe, when the northern hemiſphere inclines towards the ſun, the ſouthern declines from him.

347 Why the ſun appears bigger in winter than in ſummer.

The earth's orbit being elliptical, and the ſun conſtantly keeping in its lower focus, which is 1,617,941 miles from the middle point of the longer axis, the earth comes twice ſo much, or 3,235,882 miles nearer the ſun at one time of the year than at another; for the ſun appearing under a larger angle in our winter than ſummer, proves that the earth is nearer the ſun in winter. But here this natural queſtion will ariſe, Why have we not the hotteſt weather when the earth is neareſt the ſun? In anſwer it muſt be obſerved, that the eccentricity of the earth's orbit, or 1,617,941 miles, bears no greater proportion to the earth's mean diſtance from the ſun than 17 does to 1000; and therefore this ſmall difference of diſtance cannot occaſion any great difference of heat or cold. But the principal cauſe of this difference is, that in winter the ſun's rays fall ſo obliquely upon us, that any given number of them is ſpread over a much greater portion of the earth's ſurface where we live; and therefore each point muſt then have fewer rays than in ſummer. Moreover, there comes a greater degree of cold in the long winter-nights than there can return of heat in ſo ſhort days; and on both theſe accounts the the cold muſt increaſe. But in ſummer the ſun's rays fall more perpendicularly upon us; and therefore come with greater force, and in greater numbers, on the ſame place; and by their long continuance, a much greater degree of heat it imparted by day than can fly off by night. Beſides, thoſe parts which are once heated, retain the heat for ſome time; which, with the additional heat daily imparted,

makes

Particular Explication of the Celestial Phenomena.

makes it continue to increase, though the sun declines towards the south: and this is the reason why July is hotter than June, although the sun has withdrawn from the summer tropic; as we find it is generally hotter at three in the afternoon, when the sun has gone towards the west, than at noon when he is on the meridian. Likewise those places which are well cooled require time to be heated again; for the sun's rays do not heat even the surface of any body till they have been some time upon it. And therefore we find January for the most part colder than December, although the sun has withdrawn from the winter tropic, and begins to dart his beams more perpendicularly upon us. An iron bar is not heated immediately upon being in the fire, nor grows cold till some time after it has been taken out.

It has been already observed, that by the earth's motion on its axis, there is more matter accumulated all around the equatorial parts than any where else on the earth.

The sun and moon, by attracting this redundancy of matter bring the equator sooner under them in every return towards it, than if there was no such accumulation. Therefore, if the sun sets out, as from any star or other fixed point in the heavens, the moment when he is departing from the equinoctial or from either tropic, he will come to the same equinox or tropic again 20 min. 17¼ sec. of time, or 50 seconds of a degree, before he completes his course, so as to arrive at the same fixed star or point from whence he set out. For the equinoctial points recede 50 seconds of a degree westward every year, contrary to the sun's annual progressive motion.

When the sun arrives at the same equinoctial or solstitial point, he finishes what we call the *Tropical Year*; which, by observation, is found to contain 365 days 5 hours 48 minutes 57 seconds: and when he arrives at the same fixed star again, as seen from the earth, he completes the sidereal year, which contains 365 days 6 hours 9 minutes 14¼ seconds. The sidereal year is therefore 20 minutes 17¼ seconds longer than the solar or tropical year, and 9 minutes 14¼ seconds longer than the Julian or the civil year, which we state at 365 days 6 hours, so that the civil year is almost a mean between the sidereal and tropical.

As the sun describes the whole ecliptic, or 360 degrees, in a tropical year, he moves 50′ 8″ of a degree every day at a mean rate; and consequently 50″ of a degree in 20 minutes 17¼ seconds of time: therefore he will arrive at the same equinox or solstice when he is 50″ of a degree short of the same star or fixed point in the heavens from which he set out the year before. So that, with respect to the fixed stars, the sun and equinoctial points fall back (as it were) 30 degrees in 2160 years, which will make the stars appear to have gone 30 deg. forward with respect to the signs of the ecliptic in that time: for the same signs always keep in the same points of the ecliptic, without regard to the constellations.

348 Precession of the equinoxes explained. Fig. 181.

To explain this by a figure, let the sun be in conjunction with a fixed star at S, suppose in the 30th degree of ♉, at any given time. Then, making 2160 revolutions through the ecliptic VWX, at the end of so many sidereal years, he will be found again at S: but at the end of so many Julian years, he will be found at M, short of S: and at the end of so many tropical years he will be found short of M, in the 30th deg. of Taurus at T, which has receded back from S to T in that time, by the precession of the equinoctial points ♈ Aries and ♎ Libra. The arc ST will be equal to the amount of the precession of the equinox in 2160 years, at the rate of the 50″ of a degree, or 20 minutes 17¼ seconds of time annually; this, in so many years, makes 30 days 10½ hours, which is the difference between 2160 sidereal and tropical years; and the arc MT will be equal to the space moved through by the sun in 2160 times 11 min. 8 sec. or 16 days 13 hours 48 minutes, which is the difference between 2160 Julian and tropical years.

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349 Anticipation of the equinoxes explained.

The anticipation of the equinoxes, and consequently of the seasons, is by no means owing to the precession of the equinoctial and solstitial points in the heavens (which can only affect the apparent motions, places, and declinations, of the fixed stars), but to the difference between the civil and solar year, which is 11 minutes 3 seconds; the civil year containing 365 days 6 hours, and the solar year 365 days 5 hours 48 minutes 57 seconds.

The above 11 minutes 3 seconds, by which the civil or Julian year exceeds the solar, amounts to 11 days in 1433 years; and so much our seasons have fallen back with respect to the days of the months, since the time of the Nicene council in A. D. 325; and therefore, in order to bring back all the fasts and festivals to the days then settled, it was requisite to suppress 11 nominal days: and, that the same seasons might be kept to the same times of the year for the future, to leave out the bissextile-day in February at the end of every century of years not divisible by 4; reckoning them only common years, as the 17th, 18th, and 19th centuries, viz. the years 1700, 1800, 1900, &c. because a day intercalated every fourth year was too much; and retaining the bissextile-day at the end of those centuries of years which are divisible by 4, as the 16th, 20th, and 24th centuries, viz. the years 1600, 2000, 2400, &c. otherwise, in length of time, the seasons should be quite reversed with regard to the months of the year; though it would have required near 23,783 years to have brought about such a total change. If the earth had made exactly 365¼ diurnal rotations on its axis, whilst it revolved from any equinoctial or solstitial point to the same again, the civil and solar years would always have kept pace together, and the style would never have needed any alteration.

Having thus mentioned the cause of the precession of the equinoctial points in the heavens, which occasions a slow deviation of the earth's axis from its parallelism, and thereby a change of the declination of the stars from the equator, together with a slow apparent motion of the stars forward with respect to the signs of the ecliptic, we shall now explain the phenomena by a diagram.

Let NZSVL be the earth, SONA its axis produced to the starry heavens, and terminating in A, the present north pole of the heavens, which is vertical to N the north pole of the earth. Let EOQ be the equator, T♋Z the tropic of Cancer, and VT ♑ the tropic of Capicorn; VOZ the ecliptic, and BO its axis, both which are immoveable among the stars. But as the equinoctial points recede in the ecliptic, the earth's Fig. 182.

Fig. 170.

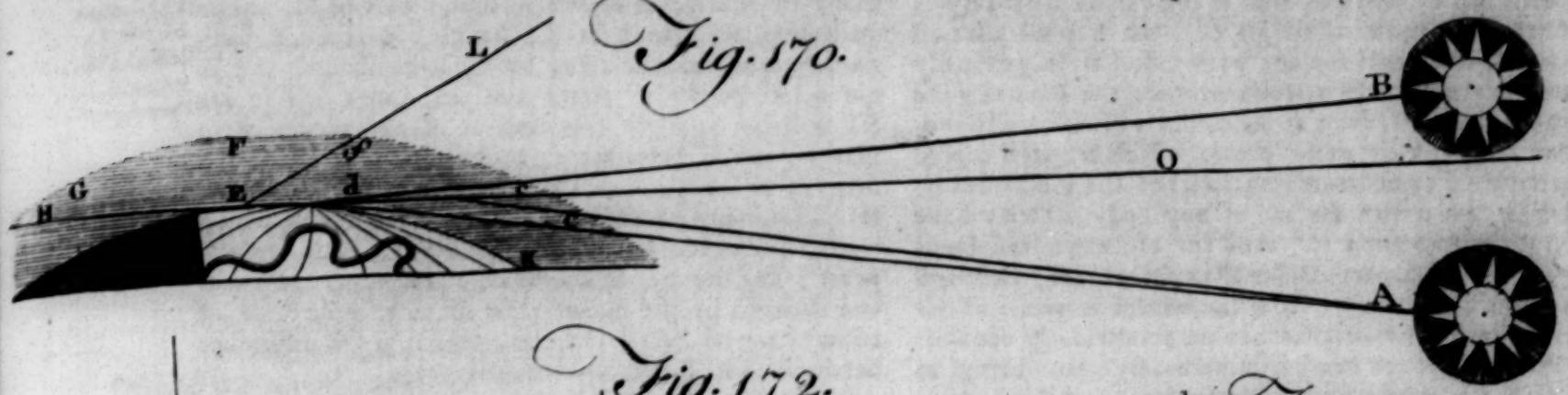


Fig. 172.

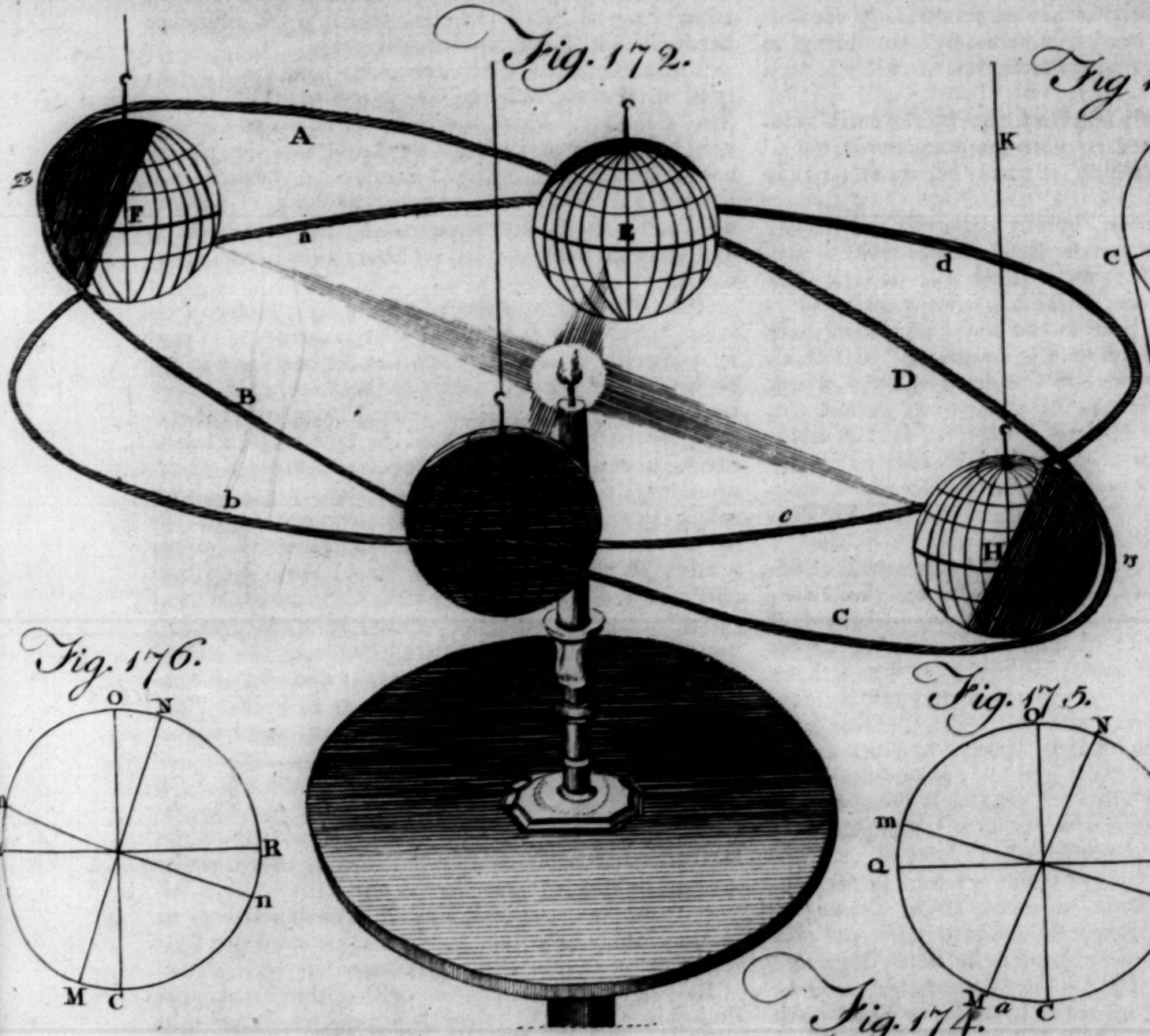


Fig 173

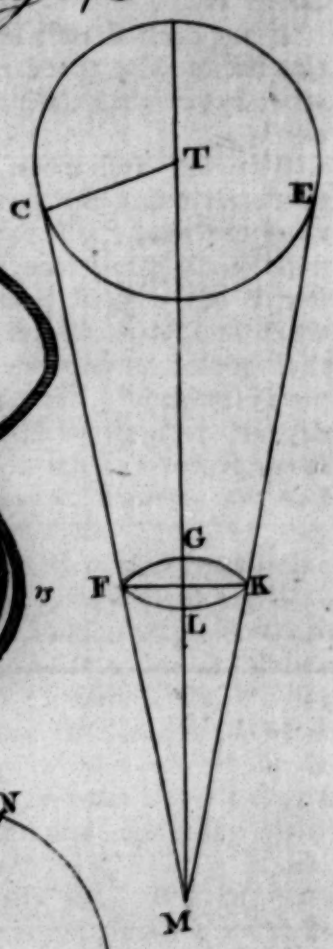


Fig. 176.

Fig. 175.

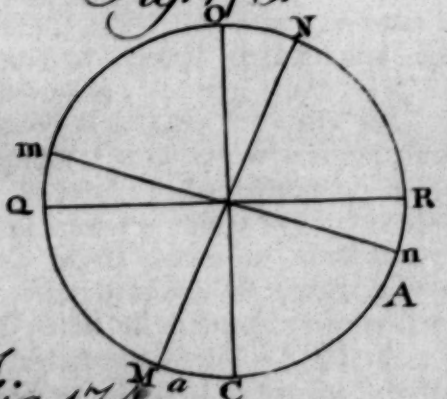


Fig. 174.

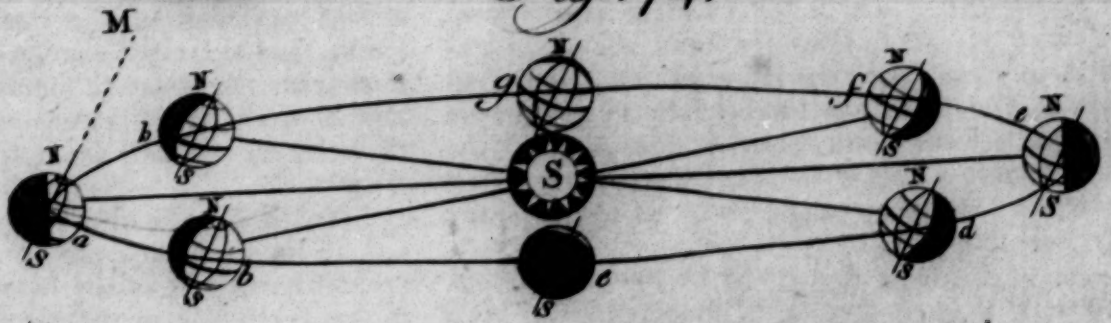
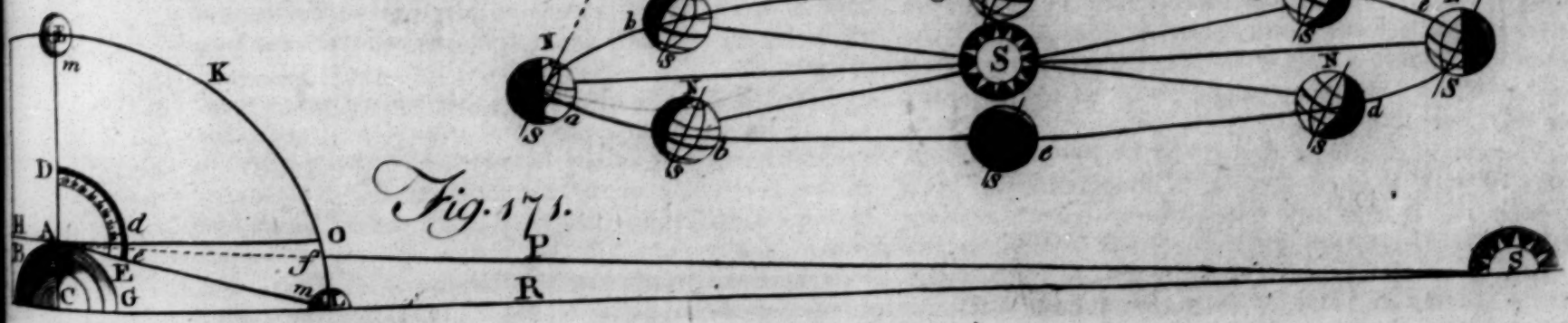


Fig. 171.



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Particular Explication of the Celeſtial Phenomena.

axis SON is in motion upon the earth's centre O, in ſuch a manner as to deſcribe the double cone NO*n* and SO*s*, round the axis of the ecliptic BO, in the time that the equinoctial points move quite round the ecliptic, which is 25,920 years; and in that length of time, the north pole of the earth's axis produced, deſcribes the circle ABCDA in the ſtarry heavens, round the pole of the ecliptic, which keeps immoveable in the centre of that circle. The earth's axis being 23½ degrees inclined to the axis of the ecliptic, the circle ABCDA deſcribed by the north pole of the earth's axis produced to A, is 47 degrees in diameter, or double the inclination of the earth's axis. In conſequence of this, the point A, which at preſent is the north pole of the heavens, and near to a ſtar of the ſecond magnitude in the tail of the conſtellation called the *Little Bear*, muſt be deſerted by the earth's axis; which moving backwards a degree every 72 years, will be directed towards the ſtar or point B in 6480 years hence; and in double of that time, or in 12,960 years, it will be directed towards the ſtar or point C, which will then be the north pole of the heavens, although it is at preſent 8½ degrees ſouth of the zenith of London L. The preſent poſition of the equator EOQ will then be changed into *e*O*q*, the tropic of Cancer T ♋ Z; into V*t* ♋, and the tropic of Capricorn VT ♑ into *t*♑ Z; as is evident by the figure. And the ſun, in the ſame part of the heavens where he is now over the earthly tropic of Capricorn, and makes the ſhorteſt days and longeſt nights in the northern hemiſphere, will then be over the earthly tropic of Cancer, and make the days longeſt and nights ſhorteſt. So that it will require 12,960 years yet more, or 25,920 from the then preſent time, to bring the north pole N quite round, ſo as to be directed toward that point of the heavens which is vertical to it at preſent. And then, and not till then, the ſame ſtars which at preſent deſcribe the equator, tropics, and polar circles, &c. by the earth's diurnal motion, will deſcribe them over again.

From the ſhifting of the equinoctial points, and with them all the ſigns of the ecliptic, it follows that thoſe ſtars which in the infancy of aſtronomy were in Aries are now got into Taurus; thoſe of Taurus into Gemini, &c. Hence likewiſe it is that the ſtars which roſe or ſet at any particular ſeaſon of the year, in the times of Heſiod, Eudoxus, Virgil, Pliny, &c. by no means anſwer at this time to their deſcriptions.

350 Of the moon.

The moon is not a planet, but only a ſatellite or attendant of the earth, going round the earth from change to change in 29 days 12 hours and 44 minutes, and round the ſun with it every year. The moon's diameter is 2,180 miles; and her diſtance from the earth's centre is 240,000. She goes round her orbit in 27 days 7 hours 43 minutes, moving about 2290 miles every hour; and turns round her axis exactly in the time that ſhe goes round the earth, which is the reaſon of her keeping always the ſame ſide towards us, and that her day and night taken together is as long as our lunar month.

351 Reflects the ſun's light.

The moon is an opaque globe like the earth, and ſhines only by reflecting the light of the ſun: therefore, whilſt that half of her which is towards the ſun is enlightened, the other half muſt be dark and inviſible. Hence ſhe diſappears when ſhe comes between us and the ſun; becauſe her dark ſide is then towards us. When ſhe is gone a little way forward, we ſee a little of her enlightened ſide: which ſtill increaſes to our view as ſhe advances forward, until ſhe comes to be oppoſite to the ſun; and then her whole enlightened ſide is towards the earth, and ſhe appears with a round illumined orb, which we call the *full moon*; her dark ſide being then turned away from the earth. From the full ſhe ſeems to decreaſe gradually as ſhe goes through the other half of her courſe; ſhowing us leſs and leſs of her enlightened ſide every day, till her next change or conjunction with the ſun, and then ſhe diſappears as before.

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The moon has ſcarce any difference of ſeaſons: her axis being almoſt perpendicular to the ecliptic. What is very ſingular, one half of her has no darkneſs at all; the earth conſtantly affording it a ſtrong light in the ſun's abſence; while the other half has a fortnight's darkneſs and a fortnight's light by turns.

352 Earth appears a moon to our moon.

Our earth is thought to be a moon to the moon; waxing and waning regularly, but appearing 13 times as big, and affording her 13 times as much light as ſhe does us. When ſhe changes to us, the earth appears full to her: and when ſhe is in her firſt quarter to us, the earth is in its third quarter to her; and *vice verſa*.

But from one half of the moon the earth is never ſeen at all: from the middle of the other half, it is always ſeen over head; turning round almoſt 30 times as quick as the moon does. From the circle which limits our view of the moon, only one half of the earth's ſide next her is ſeen; the other half being hid below the horizon of all places on that circle. To her the earth ſeems to be the biggeſt body in the univerſe; for it appears 13 times as big as ſhe does to us.

As the earth turns round its axis, the ſeveral continents, ſeas, and iſlands, appear to the moon's inhabitants like ſo many ſpots of different forms and brightneſs, moving over its ſurface; but much fainter at ſome times than others, as our clouds cover them or leave them. By theſe ſpots the Lunarians can determine the time of the earth's diurnal motion, juſt as we do the motion of the ſun: and perhaps they meaſure their time by the motion of the earth's ſpots; for they cannot have a truer dial.

353 How the Lunar inhabitants can meaſure their year.

The moon's axis is ſo nearly perpendicular to the ecliptic, that the ſun never removes ſenſibly from her equator; and the obliquity of her orbit, which is next to nothing as ſeen from the ſun, cannot cauſe the ſun to decline ſenſibly from her equator. Yet her inhabitants are not deſtitute of means for aſcertaining the length of their year, though their method and ours muſt differ. For we can know the length of our year by the return of our equinoxes; but the Lunarians, having always equal day and night, muſt have recourſe to another method: and we may ſuppoſe, they meaſure their year by obſerving when either of the poles of our earth begins to be enlightened and the other to diſappear, which is always at our equinoxes; they being conveniently ſituated for obſerving great tracts of land about our earth's poles, which are entirely unknown to us. Hence we may conclude, that the year is of the ſame abſolute length both to the earth and the moon, though very different as to the number of days: we having 365¼ natural days, and the Lunarians only 12$\frac{7}{19}$, every day and night in the moon being as long as 29½ on the earth.

The moon's inhabitants on the ſide next the earth

Particular Explication of the Celeſtial Phenomena.

may as eaſily find the longitude of their places as we can find the latitude of ours. For the earth keeping conſtantly, or very nearly ſo, over one meridian of the moon, the eaſt or weſt diſtances of places from that meridian are as eaſily found as we can find our diſtance from the equator by the altitude of our celeſtial poles.

354 Longitude eaſily found.

As the ſun can only enlighten that half of the earth which is at any moment turned towards him, and, being withdrawn from the oppoſite half, leaves it in darkneſs; ſo he likewiſe doth to the moon: only with this difference, that as the earth is ſurrounded by an atmoſphere, we have twilight after the ſun ſets; but if the moon has none of her own, nor is included in that of the earth, the lunar inhabitants have an immediate tranſition from the brighteſt ſun-ſhine to the blackeſt darkneſs. For, let t r k s w be the earth, and A, B, C, D, E, F, G, H, the moon in eight different parts of her orbit. As the earth turns round its axis from weſt to eaſt, when any place comes to t, the twilight begins there, and when it revolves from thence to r the ſun S riſes; when the place comes to s the ſun ſets, and when it comes to w the twilight ends. But as the moon turns round her axis, which is only once a month, the moment that any point of her ſurface comes to *r* (ſee the moon at G), the ſun riſes there without any previous warning by twilight; and when the ſame point comes to *s* the ſun ſets, and that point goes into darkneſs as black as at midnight.

Fig. 183.

355 Her phaſes explained.

The moon being an opaque ſpherical body (for her hills take off no more from her roundneſs than the inequalities on the ſurface of an orange takes off from its roundneſs), we can only ſee that part of the enlightened half of her which is towards the earth. And therefore, when the moon is at A, in conjunction with the ſun S, her dark half is towards the earth, and ſhe diſappears, as at *a*, there being no light on that half to render it viſible. When ſhe comes to her firſt octant at B, or has gone an eighth part of her orbit from her conjunction, a quarter of her enlightened ſide is towards the earth, and ſhe appears horned, as at *b*. When ſhe has gone a quarter of her orbit from between the earth and ſun to C, ſhe ſhows us one half of her enlightened ſide, as at *c*, and we ſay ſhe is a quarter old. At D, ſhe is in her ſecond octant; and by ſhowing us more of her enlightened ſide ſhe appears gibbous, as at *d*. At E, her whole enlightened ſide is towards the earth; and therefore ſhe appears round, as at *e*; when we ſay it is full moon. In her third octant at F, part of her dark ſide being towards the earth, ſhe again appears gibbous, and is on the decreaſe, as at *f*. At G, we ſee juſt one half of her enlightened ſide; and ſhe appears half decreaſed, or in her third quarter, as at *g*. At H, we only ſee a quarter of her enlightened ſide, being in her fourth octant; where ſhe appears horned, as at *h*. And at A, having completed her courſe from the ſun to the ſun again, ſhe diſappears; and we ſay it is new moon. Thus, in going from A to E, the moon ſeems continually to increaſe; and in going from E to A, to decreaſe in the ſame proportion; having like phaſes at equal diſtances from A to E, but as ſeen from the ſun S ſhe is always full.

356 Never appears perfectly round.

The moon appears not perfectly round when ſhe is full in the higheſt or loweſt part of her orbit, becauſe we have not a full view of her enlightened ſide at that time. When full in the higheſt part of her orbit, a ſmall deficiency appears on her lower edge; and the contrary when full in the loweſt part of her orbit.

Particular Explication of the Celeſtial Phenomena.

It is plain by the figure, that when the moon changes to the earth, the earth appears full to the moon; and *vice verſa*. For when the moon is at A, new to the earth, the whole enlightened ſide of the earth is towards the moon; and when the moon is at E, full to the earth, its dark ſide is towards her. Hence a new moon anſwers to a full earth, and a full moon to a new earth. The quarters are alſo reverſed to each other.

357 Agreeable repreſentation of her phaſes.

Between the third quarter and change, the moon is frequently viſible in the forenoon, even when the ſun ſhines; and then ſhe affords us an opportunity of ſeeing a very agreeable appearance, wherever we find a globular ſtone above the level of the eye, as ſuppoſe on the top of a gate. For, if the ſun ſhines on the ſtone, and we place ourſelves ſo as the upper part of the ſtone may juſt ſeem to touch the point of the moon's lowermoſt horn, we ſhall then ſee the enlightened part of the ſtone exactly of the ſame ſhape with the moon; horned as ſhe is, and inclined the ſame way to the horizon. The reaſon is plain: for the ſun enlightens the ſtone the ſame way as he does the moon: and both being globes, when we put ourſelves into the above ſituation, the moon and ſtone have the ſame poſition to our eyes; and therefore we muſt ſee as much of the illuminated part of the one as of the other.

The poſition of the moon's cuſps, or a right line touching the points of her horns, is very differently inclined to the horizon at different hours of the ſame days of her age. Sometimes ſhe ſtands, as it were, upright on her lower horn, and then ſuch a line is perpendicular to the horizon: when this happens, ſhe is in what the aſtronomers call *the nonageſimal degree*; which is the higheſt point of the ecliptic above the horizon at that time, and is 90 degrees from both ſides of the horizon where it is then cut by the ecliptic. But this never happens when the moon is on the meridian, except when ſhe is at the very beginning of Cancer or Capricorn.

358 Nonageſimal degree.

That the moon turns round her axis in the time that ſhe goes round her orbit, is quite demonſtrable; for, a ſpectator at reſt; without the periphery of the moon's orbit, would ſee all her ſides turned regularly towards him in that time. She turns round her axis from any ſtar to the ſame ſtar again in 27 days 8 hours; from the ſun to the ſun again in 29½ days: the former is the length of the ſidereal day, and the latter the length of her ſolar day. A body moving round the ſun would have a ſolar day in every revolution, without turning on its axis; the ſame as if it had kept all the while at reſt, and the ſun moved round it: but without turning round its axis it could never have one ſidereal day, becauſe it would always keep the ſame ſide towards any given ſtar.

If the earth had no annual motion, the moon would go round it ſo as to complete a lunation, a ſidereal, and a ſolar day, all in the ſame time. But, becauſe the earth goes forward in its orbit while the moon goes round the earth in her orbit, the moon muſt go as much more than round her orbit from change to change

in

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in completing a solar day, as the earth has gone forward in its orbit during that time, i. e. almost a twelfth part of a circle.

359 Delineation of her path round the sun.

If the earth had no annual motion, the moon's motion round the earth, and her track in open space, would be always the same (c). But as the earth and moon move round the sun, the moon's real path in the heavens is very different from her visible path round the earth; the latter being in a progressive circle, and the former in a curve of different degrees of concavity, which would always be the same in the same parts of the heavens, if the moon performed a complete number of lunations in a year without any fraction.

Let a nail in the end of the axle of a chariot-wheel represent the earth, and a pin in the nave the moon; if the body of the chariot be propped up so as to keep that wheel from touching the ground, and the wheel be then turned round by hand, the pin will describe a circle both round the nail and in the space it moves through. But if the props be taken away, the horses put to, and the chariot driven over a piece of ground which is circularly convex; the nail in the axle will describe a circular curve, and the pin in the nave will still describe a circle round the progressive nail in the axle, but not in the space through which it moves. In this case, the curve described by the nail will resemble in miniature as much of the earth's annual path round the sun, as it describes whilst the moon goes as often round the earth as the pin does round the nail: and the curve described by the pin will have some resemblance of the moon's path during so many lunations.

Fig. 184.

Let us now suppose that the radius of the circular curve described by the nail in the axle is to the radius of the circle which the pin in the nave describes round the axle, as 337$\frac{1}{7}$ to 1; (D) which is the proportion of the radius or semidiameter of the earth's orbit to that of the moon's, or of the circular curve A 1 2 3 4 5 6 7 B, &c. to the little circle *a*; and then, whilst the progressive nail describes the said curve from A to E, the pin will go once round the nail with regard to the centre of its path, and in so doing will describe the curve *a b c d e*. The former will be a true representation of the earth's path for one lunation, and the latter of the moon's for that time. Here we may set aside the inequalities of the moon's motion, and also the earth's moving round its common centre of gravity and the moon's: all which, if they were truly copied in this experiment, would not sensibly alter the figure of the paths described by the nail and pin, even though they should rub against a plain upright surface all the way, and leave their tracts visible upon it. And if the chariot was driven forward on such a convex piece of ground, so as to turn the wheel several times round, the track of the pin in the nave would still be concave towards the centre of the circular curve described by the nail in the axle; as the moon's path is always concave to the sun in the centre of the earth's annual orbit.

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In this diagram, the thickest curve line ABCDE, with the numeral figures set to it, represents as much of the earth's annual orbit as it describes in 32 days from west to east; the little circles at A, B, C, D, E, show the moon's orbit in due proportion to the earth's; and the smallest curve *a* C *f* represents the line of the moon's path in the heavens for 32 days, accounted from any particular new moon at *a*. The sun is supposed to be in the centre of the curve A 1 2 3 4 5 6 7 B, &c. and the small dotted circles upon it represent the moon's orbit, of which the radius is in the same proportion to the earth's path in this scheme, that the radius of the moon's orbit in the heavens was supposed to bear to the radius of the earth's annual path round the sun; that is, as 240,000, to 81,000,000, or as 1 to 337$\frac{1}{7}$.

When the earth is at A, the new moon is at *a*; and in the seven days that the earth describes the curve 1 2 3 4 5 6 7, the moon in accompanying the earth describes the curve *a b*; and is in her first quarter at *b* when the earth is at B. As the earth describes the curve B 8 9 10 11 12 13 14, the moon describes the curve *b c*; and is at *c*, opposite to the sun, when the earth is at C. Whilst the earth describes the curve C 15 16 17 18 19 20 21 22, the moon describes the curve *c d*; and is in her third quarter at *d* when the earth is at D. And lastly, whilst the earth describes the curve D 23 24 25 26 27 28 29, the moon describes the curve *d e*; and is again in conjunction at *e* with the sun when the earth is at E, between the 29th and 30th day of the moon's age, accounted by the numeral figures from the new moon at A. In describing the curve *a* C *e*, the moon goes round the progressive earth as really as if she had kept in the dotted circle A, and the earth continued immoveable in the centre of that circle.

360 Her path always concave to the sun.

And thus we see, that although the moon goes round the earth in a circle, with respect to the earth's centre, her real path in the heavens is not very different in appearance from the earth's path. To show that the moon's path is concave to the sun, even at the time of change, it is carried on a little farther into a second lunation as to *f*.

The curves which Jupiter's satellites describe, are all of different sorts from the path described by our moon, although these satellites go round Jupiter as the moon goes round the earth. Let ABCDE, &c. be as much of Jupiter's orbit as he describes in 18 days from A to T; and the curves *a*, *b*, *c*, *d*, will be the paths of his four moons going round him in his progressive motion. Now let us suppose all these moons to set out from a conjunction with the sun, as seen from Jupiter at A; then, his first or nearest moon will be at *a*, his second at *b*, his third at *c*, and his fourth at *d*. At the end of 24 terrestrial hours after this

Fig. 185.

(c) In this place, we may consider the orbits of all the satellites as circular, with respect to their primary planets; because the eccentricities of their orbits are too small to affect the phenomena here described.

(D) The figure by which this is illustrated is borrowed from Mr Ferguson. Later observations have determined the proportions to be different: but we cannot find that any delineation of this kind hath been given by astronomers, according to the new proportions.

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conjunction, Jupiter has moved to B, his firſt moon or ſatellite has deſcribed the curve *a* 1, his ſecond the curve *b* 1, his third *c* 1, and his fourth *d* 1. The next day, when Jupiter is at C, his firſt ſatellite has deſcribed the curve *a* 2, from its conjunction, his ſecond the curve *b* 2, his third the curve *c* 2, and his fourth the curve *d* 2, and ſo on. The numeral figures under the capital letters ſhow Jupiter's place in his path every day for 18 days, accounted from A to T; and the like figures ſet to the paths of his ſatellites, ſhow where they are at the like times. The firſt ſatellite, almoſt under C, is ſtationary at + as ſeen from the ſun, and retrograde from + to 2: at 2 it appears ſtationary again, and thence it moves forward until it has paſt 3, and is twice ſtationary and once retrograde between 3 and 4. The path of this ſatellite interſects itſelf every 42½ hours, making ſuch loops as in the diagram at 2. 3. 5. 9. 10. 12. 14. 16. 18. a little after every conjunction. The ſecond ſatellite *b*, moving ſlower, barely croſſes its path every 3 days 13 hours; as at 4. 7. 11. 14. 18, making only five loops and as many conjunctions in the time that the firſt makes ten. The third ſatellite *c* moving ſtill ſlower, and having deſcribed the curve *c* 1. 2. 3. 4. 5. 6. 7. comes to an angle at 7 in conjunction with the ſun at the end of 7 days 4 hours; and ſo goes on to deſcribe ſuch another curve 7. 8. 9. 10. 11. 12. 13. 14. and is at 14 in its next conjunction. The fourth ſatellite *d* is always progreſſive, making neither loops nor angles in the heavens; but comes to its next conjunction at *e* between the numeral figures 16 and 17, or in 16 days 18 hours.

The method uſed by Mr Ferguſon to delineate the paths of theſe ſatellites was the following. Having drawn their orbits on a card, in proportion to their relative diſtances from Jupiter, he meaſured the radius of the orbit of the fourth ſatellite, which was an inch and $\frac{14}{166}$ parts of an inch; then multiplied this by 424 for the radius of Jupiter's orbit, becauſe Jupiter is 424 times as far from the ſun's centre as his fourth ſatellite is from his centre; and the product thence ariſing was $483\frac{36}{166}$ inches. Then taking a ſmall cord of this length, and fixing one end of it to the floor of a long room by a nail, with a black-lead pencil at the other end, he drew the curve ABCD, &c. and ſet off a degree and half thereon from A to T; becauſe Jupiter moves only ſo much, whilſt his outermoſt ſatellite goes once round him, and ſomewhat more; ſo that this ſmall portion of ſo large a circle differs but very little from a ſtraight line. This done, he divided the ſpace AT into 18 equal parts, as AB, BC, &c. for the daily progreſs of Jupiter; and each part into 24 for his hourly progreſs. The orbit of each ſatellite was alſo divided into as many equal parts as the ſatellite is hours in finiſhing its ſynodical period round Jupiter. Then drawing a right line through the centre of the card, as a diameter to all the four orbits upon it, he put the card upon the line of Jupiter's motion, and transferred it to every horary diviſion thereon, keeping always the ſaid diameter-line on the line of Jupiter's path; and running a pin through each horary diviſion in the orbit of each ſatellite as the card was gradually transferred along the line ABCD, &c. of Jupiter's motion, he marked points for every hour through the card for the curves deſcribed by the ſatellites, as the primary planet in the centre of the card was carried forward on the line; and ſo finiſhed the figure, by drawing the lines of each ſatellite's motion through thoſe (almoſt innumerable) points: by which means, this is perhaps as true a figure of the paths of the ſatellites as can be deſired. And in the ſame manner might thoſe of Saturn's ſatellites be delineated.

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It appears by the ſcheme, that the three firſt ſatellites come almoſt into the ſame line or poſition every ſeventh day; the firſt being only a little behind with the ſecond, and the ſecond behind with the third. But the period of the fourth ſatellite is ſo incommenſurate to the periods of the other three, that it cannot be gueſſed at by the diagram when it would fall again into a line of conjunction with them, between Jupiter and the ſun. And no wonder; for ſuppoſing them all to have been once in conjunction, it will require 3,087,043,493,260 years to bring them in conjunction again.

The moon's abſolute motion from her change to her firſt quarter, or from *a* to *b*, is ſo much ſlower than the earth's that ſhe falls 240,000 miles (equal to the ſemidiameter of her orbit) behind the earth at her firſt quarter in *b*, when the earth is in B; that is, ſhe falls back a ſpace equal to her diſtance from the earth. From that time her motion is gradually accelerated to her oppoſition or full at *c*; and then ſhe is come up as far as the earth, having regained what ſhe loſt in her firſt quarter from *a* to *b*. From the full to the laſt quarter at *d*, her motion continues accelerated ſo as to be juſt as far before the earth at *d* as ſhe was behind it at her firſt quarter in *b*. But from *d* to *e* her motion is retarded ſo, that ſhe loſes as much with reſpect to the earth as is equal to her diſtance from it, or to the ſemidiameter of her orbit; and by that means ſhe comes to *e*, and is then in conjunction with the ſun as ſeen from the earth at E. Hence we find, that the moon's abſolute motion is ſlower than the earth's from her third quarter to her firſt, and ſwifter than the earth's from her firſt quarter to her third; her path being leſs curved than the earth's in the former caſe and more in the latter. Yet it is ſtill bent the ſame way towards the ſun; for if we imagine the concavity of the earth's orbit to be meaſured by the length of a perpendicular line G *g*, let down from the earth's place upon the ſtraight line *b g d* at the full of the moon, and connecting the places of the earth at the end of the moon's firſt and third quarters, that length will be about 640,000 miles; and the moon when new only approaching nearer to the ſun by 240,000 miles than the earth is, the length of the perpendicular let down from her place at that time upon the ſame ſtraight line, and which ſhows the concavity of that part of her path, will be about 400,000 miles.

561 A difficulty concerning attraction ſolved.

The moon's path being concave to the ſun throughout, demonſtrates that her gravity towards the ſun, at her conjunction, exceeds her gravity towards the earth; and if we conſider that the quantity of matter in the ſun is vaſtly greater than the quantity of matter in the earth, and that the attraction of each body diminiſhes as the ſquare of the diſtance from it increaſes, we ſhall ſoon find, that the point of equal attraction between the earth and the ſun, is much nearer the earth than the moon is at her change. It may then appear ſurpriſing that the moon does not abandon the earth when

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when she is between it and the sun, because she is considerably more attracted by the sun than by the earth at that time. But this difficulty vanishes when we consider, that a common impulse on any system of bodies affects not their relative motions; but that they will continue to attract, impel, or circulate round one another, in the same manner as if there was no such impulse. The moon is so near the earth, and both of them so far from the sun, that the attractive power of the sun may be considered as equal on both; and therefore the moon will continue to circulate round the earth in the same manner as if the sun did not attract them at all: like bodies in the cabin of a ship, which may move round or impel one another in the same manner when the ship is under sail as when it is at rest; because they are all equally affected by the common motion of the ship. If by any other cause, such as the near approach of a comet, the moon's distance from the earth should happen to be so much increased, that the difference of their gravitating forces towards the sun should exceed that of the moon towards the earth; in that case, the moon, when in conjunction, would abandon the earth, and be either drawn into the sun, or comet, or circulate round about it.

The ruggedness of the moon's surface mentioned n° 146, 147. is of great use to us, by reflecting the sun's light to all sides: for if the moon were smooth and polished like a looking-glass, or covered with water, she could never distribute the sun's light all round; only in some positions she would show us his image, no bigger than a point, but with such a lustre as would be hurtful to our eyes.

362 Why her edge appears always even.

The moon's surface being so uneven, many have wondered why her edge appears not jagged, as well as the curve bounding the light and dark places. But if we consider, that what we call the *edge* of the moon's disk is not a single line set round with mountains, in which case it would appear irregularly indented, but a large zone having many mountains lying behind one another from the observer's eye, we shall find that the mountains in some rows will be opposite to the vales in others; and so fill up the inequalities as to make her appear quite round: just as when one looks at an orange, although its roughness be very discernible on the side next the eye, especially if the sun or a candle shines obliquely upon that side, yet the line terminating the visible part still appears smooth and even.

Having said thus much of the moon's Period, Phases, Path, &c. it may not be amiss to describe, in a summary manner, the irregularities of her motion; and though these have been already treated of on the principles of the Newtonian system, yet as the subject has much embarrassed the astronomical world, it is hoped, that the following explanation of the planetary irregularities upon common mechanical principles, from Mr Nicholson's Natural Philosophy, may not appear superfluous to uninformed readers.

Philadelphia Edition, 184 *et seq.*

"If the sun were at rest, and the planets did not mutually gravitate towards each other, they would describe ellipses, having the sun in the common focus: But since they mutually act on the sun and on each other, it must follow that the sun is perpetually moved about the centre of gravity of all the planets; which centre is the common focus of all their orbits. This centre, by reason of the sun's very great bulk, can in no situation exceed the distance of its semidiameter from its surface. Some small irregularities arise from these mutual actions, but much less would ensue if the sun were at rest, or not subject to the reaction of the other planets. The irregularities in the motions of the primary planets are scarcely considerable enough to come under observation in the course of many revolutions; but those of the moon are very perceptible on account of its nearness to us, and from other causes. It will therefore be sufficient to explain the latter, and apply the explanation to the former, being effects of the same kind.

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"If the actions of the sun upon the earth and moon were equal upon each, according to their masses, and tended to produce motions in parallel directions, their relative motions would be the same as if no such force acted upon them. But these forces vary both in quantity and direction according to the various relative situations of the earth and moon.

"Let the point S (fig. 162) represent the sun, and ADBC the orbit of the moon. Then if the moon be at the quadrature A, the distances ES and AS of the earth and moon from the sun being equal, their gravities towards S will also be equal, and may be represented by those lines ES and AS. Draw the line A parallel and equal to ES, and join LS, which will be parallel to AE. The force AS may be resolved (from *principles of compound motion*) into the two forces AL and AE; of which AL, by reason of its parallelism and equality to ES, will not disturb their relative motions or situation: but the force AE conspiring with that of gravity, will cause the moon to fall farther below the tangent of its orbit than it would have done if no such disturbing force had existed. Therefore, at or near the quadratures, the moon's gravity towards the earth is increased more than according to the regular course, and its orbit is rendered more curve.

"When the moon is at the conjunction C, the distances ES and CS not being equal, the moon's gravitation towards the sun exceeds that of the earth in the same proportion as the square of ES exceeds the square of CS. And because the excess acts contrary to the direction of the moon's gravity towards the earth, it diminishes the effect thereof, and causes the moon to fall less below the tangent of its orbit than it would if no such disturbing force existed. A like and very nearly equal effect follows, when the moon is at the opposition D, by the earth's gravitation towards the sun being greater than that of the moon; whence their mutual gravitation is diminished as in the former case. Therefore, at or near the conjunction or opposition, the moon's gravity is diminished, and its orbit rendered less curve.

"It is found that the force added to the moon's gravity at the quadratures, is to the gravity with which it would revolve about the earth in a circle, at its present mean distance, if the sun had no effect on its motion, as 1 to 190; and that the force subducted from its gravity at the conjunction or opposition is about double this quantity. The influence of the sun, then, on the whole, increases the moon's distance from the earth, and augments its periodical time: and since this influence is most considerable when the earth is nearest the sun, or in its perihelium, its periodical time must then be the greatest;" and it is so found by observation.

"To

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"To ſhow the effect of the ſun in diſturbing the moon's motion at any ſituation between the conjunction and one of the quadratures, ſuppoſe at M, let ES repreſent the earth's gravity towards the ſun, draw the line MS, which continue towards G; from M ſet off MG, ſo that MG may be to ES as the ſquare of the earth's diſtance ES is to the ſquare of the moon's diſtance MS; and MG will repreſent the moon's gravity towards the ſun. From M draw MF parallel and equal to ES; join FG, and draw MH parallel and equal to FG. The force MG may be reſolved into MF and MH; of which MF, by reaſon of its parallelism and equality to ES, will not diſturb the relative motions or ſituations of the moon and earth: MH then is the diſturbing force. Draw the tangent MK to the moon's orbit, and continue the radius EM towards I; draw HI parallel to KM, and interſecting MI in I, and complete the parallelogram by drawing HK parallel to IM, and interſecting MK in K. The force MH may be reſolved into MI and MK; of which MI affects the gravity, and MK the velocity, of the moon. When the force MH coincides with the tangent, that is, when the moon is 35° 16′ diſtant from the quadrature, the force MI which affects the gravity, vaniſhes; and when the force MH coincides with the radius, that is, when the moon is either in the conjunction or quadrature, the force MK vaniſhes. Between the quadrature and the diſtance of 35° 16′ from it, the line or force MH falls within the tangent, and conſequently the force MI is directed towards E, and the moon's gravity is increaſed: but, at any greater diſtance from the quadrature, the line MH falls without the tangent, and the force MI is directed from E, the moon's gravity being diminiſhed. It is evident that the force MK is always directed to ſome point in the line which paſſes through the ſun and earth; therefore it will accelerate the moon's motion while it is approaching towards that line, or the conjunction, and ſimilarly retard it as it recedes from it, or approaches towards the quadrature, by conſpiring with the motion in one caſe, and ſubducting from it in the other.

"As the moon's gravity towards the ſun, at the conjunction, is diminiſhed by a quantity which is as the difference of the ſquares of their diſtances; and as this difference, on account of the very great diſtance of the ſun, is nearly the ſame when the moon is at the oppoſition, the mutual tendency to ſeparate, or diminution of gravity, will be very nearly the ſame. Whence it eaſily follows, that all the irregularities which have been explained as happening between the quadratures and conjunction, muſt, in like circumſtances, take place between the quadratures and oppoſition.

"If the moon revolved about the earth in a circular orbit, the ſun's diſturbing influence being ſuppoſed not to act, then this influence being ſuppoſed to act would convert the orbit into an ellipſis. For the increaſe of gravity renders it more curve at the quadratures, by cauſing the moon to fall further below the tangent; and the diminution of gravity, as well as the increaſed velocity, render the orbit leſs curve at the conjunction and oppoſition, by cauſing the moon to fall leſs below the tangent in a given time. Therefore, an ellipſis would be deſcribed whoſe leſs or more convex parts would be at the quadratures, and whoſe longeſt diameter would paſs through them: Conſequently the moon would be fartheſt from the earth at the quadratures, and neareſt at the conjunction and oppoſition. Neither is it ſtrange that the moon ſhould approach or come nearer to the earth at the time when its gravity is the leaſt, ſince that approach is not the immediate conſequence of the decreaſe of gravity, but of the curvity of its orbit near the quadratures; and in like manner, its receſs from the earth does not ariſe immediately from its diminiſhed gravity, from the velocity and direction acquired at the conjunction or oppoſition. But as the moon's orbit is, independent of the ſun's action, an ellipſis, then effects take place only as far as circumſtances permit. The moon's gravity towards the earth being thus ſubject to a continual change in its ratio, its orbit is of no conſtant form. The law of its gravity being nearly in the inverſe proportion of the ſquares of the diſtances, its orbit is nearly a quieſcent ellipſis; but the deviation from this law occaſions its apſides to move direct or retrograde, according as thoſe deviations are in defect or in exceſs. Aſtronomers, to reduce the motion of the apſides to computation, ſuppoſe the revolving body to move in an ellipſis, whoſe tranſverſe diameter, or line of the apſides, revolves at the ſame time about the focus of the orbit. When the moon is in the conjunction or oppoſition, the ſun ſubducts from its gravity, and that the more the greater its diſtance is from the earth; ſo that its gravity follows a greater proportion than the inverted ratio of the ſquare of the diſtance, and conſequently the apſides of its orbit muſt then move in conſequentia or direct. In the quadratures the ſun adds to the moon's gravity; and that the more the greater its diſtance is from the earth: ſo that its gravity follows a leſs proportion than the inverted ratio of the ſquare of her diſtance, and conſequently the apſides of its orbit muſt then move in antecedentia or retrograde. But becauſe the action of the ſun ſubducts more from the moon's gravity in the conjunction and oppoſition than it adds to it in the quadratures, the direct motion exceeds the retrograde, and at the end of each revolution the apſides are found to be advanced according to the order of the ſigns.

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"If the plane of the moon's orbit coincided with that of the ecliptic, theſe would be the only irregularities ariſing from the ſun's action; but becauſe it is inclined to the plane of the ecliptic in an angle of about 5 degrees, the whole diſturbing force does not act upon the moon's motion in its orbit; a ſmall part of the force being employed to draw it out of the plane of the orbit into that of the ecliptic.

"Of the forces MK and MI (fig. 162.) which diſturb the moon's motion, MI, being always in the direction of the radius, can have no effect in drawing it out of the plane of its orbit: and if the force MK really coincided with the tangent, as we, neglecting the ſmall deviation ariſing from the obliquity of the moon's orbit, have hitherto ſuppoſed, it is evident that its only effect would be that of accelerating or retarding the moon's motion, without affecting the plane of its orbit: But becauſe that force is always directed to ſome point in the line which paſſes through the centres of the ſun and earth, it is evident that it can coincide with the tangent only when that line is in the plane of the moon's orbit; that is to ſay, when the nodes are in the conjunction and oppoſition. At all other

times

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times the force MK must decline to the northward or southward of the tangent, and, compounding itself with the moon's motion, will not only accelerate or retard it, according to the circumstances before explained, but will likewise alter its direction, deflecting it towards that side of the orbit on which the point, the force MK, tends to is situated. This deflection causes the moon to arrive at the ecliptic either sooner or later than it would otherwise have done; or, in other words, it occasions the intersection of its orbit with the ecliptic to happen in a point of the ecliptic, either nearer to or farther from the moon, than that in which it would have happened if such deflection had not taken place.

"To illustrate this, let the elliptical projection COQN (fig. 163.) represent a circle in the plane of the ecliptic, MOPN the moon's orbit intersecting the ecliptic in the nodes N and O. Suppose the moon to be in the northern part of its orbit at M and moving towards the node O; the disturbing force MK, which tends towards a point in the line SE to the southward of the tangent MT, will be compounded with the tangental force, and will cause the moon to describe the arc Mm, to which MR is tangent, instead of the arc MO; whence the node O is said to be moved to m. In this manner the motion of the nodes may be explained for any other situation.

"This motion evidently depends on a twofold circumstance; namely, the quantity and direction of the force MK. If the force MK be increased, its direction remaining the same, it will deflect the curve of the moon's path from its orbit in a greater degree; and, on the other hand, if its direction be altered so as to approach nearer to a right angle with the tangent, it will cause a greater deflection, though its quantity remain the same. When the moon is in the quadratures, the force MK vanishes, consequently the nodes are then stationary. When the moon is at the octant, or 45 degrees from the quadrature, the force MK is the greatest of all; and therefore the motion of the nodes is then most considerable, as far as it depends on the quantity of MK: But the direction of this force in like circumstances depends on the situation of the line of the nodes. If the line of the nodes coincides with the line passing through the centres of the sun and earth, the force MK coincides with the tangent of the moon's orbit, and the nodes are stationary; and the farther the node is removed from that line, the farther is that line removed from the plane of the moon's orbit, till the line of the nodes is in the quadratures; at which time the line passing through the centres of the sun and earth, makes an angle with the plane of the moon's orbit equal to its whole inclination, or 5 degrees; consequently the angle formed between MK and the tangent, in like circumstances, is then greatest, MK being directed to a point in a line which is further from the plane of the moon's orbit than at any other time, and of course the motion of the nodes is then most considerable.

"To determine the quantity and direction of the motion of the nodes, suppose the moon in the quarter preceding the conjunction, and the node towards which it is moving to be between it and the conjunction; in this case its motion is directed to a point in the ecliptic which is less distant than the point towards which the force MK is directed: the force MK then compounding with the moon's motion, causes it to be directed to a point more distant than it would otherwise have been; that is to say, the node towards which the moon moves is moved towards the conjunction. When the moon has passed the node, its course is directed to the other node, which is a point in the ecliptic more distant than the point to which MK is directed, and therefore MK compounding with its motion causes it to be directed to a point less distant than it would otherwise have been; so that in this case, likewise, the ensuing node is moved towards the conjunction. After the moon has passed the conjunction, the force MK still continues to deflect its course towards the ecliptic; and consequently the motion of the node is the same way till its arrival at the quadrature. Suppose, again, the moon to be at the conjunction, and the node towards which it is moving to be between it and the quadrature; in this case, the force MK compounding with the moon's motion, causes it to move towards a point in the ecliptic less distant than it would otherwise have done; so that the ensuing node is brought towards the conjunction.

"When the moon has passed the node, the force MK still continuing to deflect its course towards the same side of its orbit, produces a contrary effect; namely, as it before occasioned it to converge to the ecliptic, so it now causes it to diverge from it; and its motion, in consequence, tends continually to a point in the ecliptic more distant than it would otherwise have done; the ensuing node in this instance being also brought towards the conjunction.

"As the disturbing forces are very nearly the same in the half of the moon's orbit which is farthest from the sun, this last paragraph is true when it moves in that part of its orbit, if the word *opposition* be every where inserted instead of the word *conjunction*.

"Whence it is easy to deduce this general rule: That when the moon is in the part of its orbit nearest the sun, the node towards which it is moving is made to move towards the conjunction; and when it is in the part of its orbit farthest from the sun, the node towards which it is moving is made to move towards the opposition.

"Suppose the moon at Q (fig. 176.), or the quadrature preceding the conjunction, then the ensuing node, if at 90° distance, or at the conjunction C, will be stationary (as before observed); but if it be at a greater or less distance it will be brought towards C. Thus, if the nodes be in the position MN, the ensuing node M, being at a less distance from Q than 90°, will move towards C, or direct, while the moon moves through the arc QM; after which N becomes the ensuing node and likewise moves towards the conjunction C, or retrograde during the moon's motion through the arc MR; and because the arc MR exceeds QM, the retrograde motion exceeds the direct. Again, if the nodes be in the position *nm*, the ensuing node *n* being at a greater distance from Q than 90°, will move towards C, or retrograde during the moon's motion through the arc Q*n*; after which the node *m* becomes the ensuing node, and likewise moves towards the conjunction C, or direct, during the moon's motion through the arc *n*R; and because the arc Q*n* exceeds NR, the retrograde motion here also exceeds the

Particular Explication of the Celestial Phenomena.

the direct. If the nodes be in the quadratures QR, the ensuing node R removes towards C, or retrograde, during the moon's motion through the arc QR, or almost the whole semiorbit. The same may be shown in the other half of the orbit ROQ with respect to the opposition O; and therefore in every revolution of the moon, the retrograde motion of the nodes exceeds the direct; and, on the whole, the nodes are carried round contrary to the order of the signs.

"The line of the conjunction is by the earth's annual motion brought into every possible situation with respect to the nodes in the course of a year, independent of their own proper motion; which last occasions the change of situation to be performed in about nineteen days less.

"The inclination of the moon's orbit being the angle which its course makes with the plane of the ecliptic, it is evident from what has been said, that this angle is almost continually changing. Suppose the line of the nodes, by its retrograde motion, to leave the conjunction C (fig. 175.) and become in the second and fourth quarters as in the position MN, and the moon to move from the node M to the node N; then, because the ensuing node N moves towards the conjunction C, while the moon is in the nearer half of its orbit, the moon's course must be continually more and more inflected towards the ecliptic till its arrival at R. This inflection in the first 90°, or MA from M, prevents its diverging so much from the ecliptic, as it would otherwise have done; that is to say, it diminishes the angle of the moon's inclination. From A to R its course begins to converge towards the ecliptic; and this convergence is increased by the inflection which, in the preceding 90°, prevented its divergence: in the arc AR, then, their inclination is increased. During the moon's motion from R to N, the node is moved towards the opposition O, and consequently the angle of its course to N, is rendered less than it would have been if the node has not moved; or, in other words, the inclination is diminished. And because the arc MA added to the arc RN is greater than the arc AR, the inclination at the subsequent node is less than at the precedent node; and the same may be shown in the other half revolution NQM.

"Therefore, while the nodes are moving from the conjunction and opposition to the quadratures, the inclination of the moon's orbit on the whole diminishes in every revolution till they arrive in the quadratures, at which time it is least of all. When the line of the nodes has passed the quadratures, and is in the first and third quarters, as in the position *mn*, it is easily shown by the same kind of argument, that the inclination is increased while the moon passes from *m* to Q, then diminishes for the remainder of the first 90°, or Q*a*, and is afterwards increased for the other 90°, or *an*; and the same may be proved for the other half revolution *n*R*m*. Consequently, while the nodes are moving from the quadratures to the conjunction and opposition, the inclination is increased by the same degrees as it before was diminished, till they arrive at the conjunction and opposition; at which time it returns to its first quantity, being then greatest of all.

"The line of the nodes in the course of one entire revolution with respect to the sun, is twice in the quadratures and twice in the conjunction and opposition. Therefore the inclination of the moon's orbit to the ecliptic is diminished and increased by turns twice in every revolution of the nodes.

"All the irregularities of the moon's motion are a little greater when in the half of its orbit nearest the sun, than when it is in the other half; the chief reason of which is, that the difference between the squares of the moon's and earth's distances from the sun is greater in proportion to the squares themselves, in the former than in the latter case at equal elongations from the quadrature; and consequently the disturbing forces must be more considerable.

"Although the moon in reality revolves about the common centre of gravity between her and the earth, and not about the earth itself, and consequently their motions and irregularities are similar, and not confined to the moon alone; yet it may be easily conceived, that the conclusions are not affected in any degree that may be here regarded, when, for the sake of conciseness, we suppose one of the two bodies to be quiescent, and the other to revolve about it.

"Irregularities of the same kind take place among the primary planets, by their mutual actions on each other; but the quantities are not considerable. Hence the apsides of the planets are found to move in consequentia, but so very slowly that some have doubted whether they move at all. The motions of the aphelia of Saturn, Jupiter, Mars, the Earth, Venus, and Mercury, as deduced from the comparison of distant observations, are respectively 2° 30′, 1° 43′ 20″, 1° 51′ 40″, 1° 49′ 10″, 4° 10′, 1° 57′ 40″, in a century.

"The actions of the inferior planets on each other are very minute, on account of the smallness of their bulks; but those of Jupiter and Saturn are not altogether insensible. When Jupiter is between the Sun and Saturn, its whole attraction acts upon the latter and increases the gravity of that planet towards the sun. This is found by comparing the respective masses of Jupiter and the Sun; and the respective squares of their distances from Saturn, to be equal to $\frac{1}{77}$ of the Sun's action upon Saturn. That planet, on the other hand, at the conjunction, acts upon Jupiter and the Sun in the same direction; and therefore disturbs their relative position only so far as its actions on each are not equal. The difference of these actions is found, by the same principles, to be $\frac{1}{11777}$ of Jupiter's whole gravity."

Sect. VI. *Of the Ebbing and Flowing of the Sea, and the Phenomena of the Harvest and Horizontal Moon.*

336 Cause of the tides discovered by Kepler.

The cause of the tides was discovered by Kepler, who, in his *Introduction to the Physic of the Heavens*, thus explains it: "The orb of the attracting power, which is in the moon, is extended as far as the earth; and draws the waters under the torrid zone, acting upon places where it is vertical, insensibly on confined seas and bays, but sensibly on the ocean whose beds are large and where the waters have the liberty of reciprocation, that is, of rising and falling." And in the 70th page of his *Lunar Astronomy*—"But the cause of the tides of the sea appears to be the bodies of the sun and moon drawing the waters of the sea." This hint being given, the immortal Sir Isaac Newton improved it,

ASTRONOMY

Plate LXXIX

Fig. 177

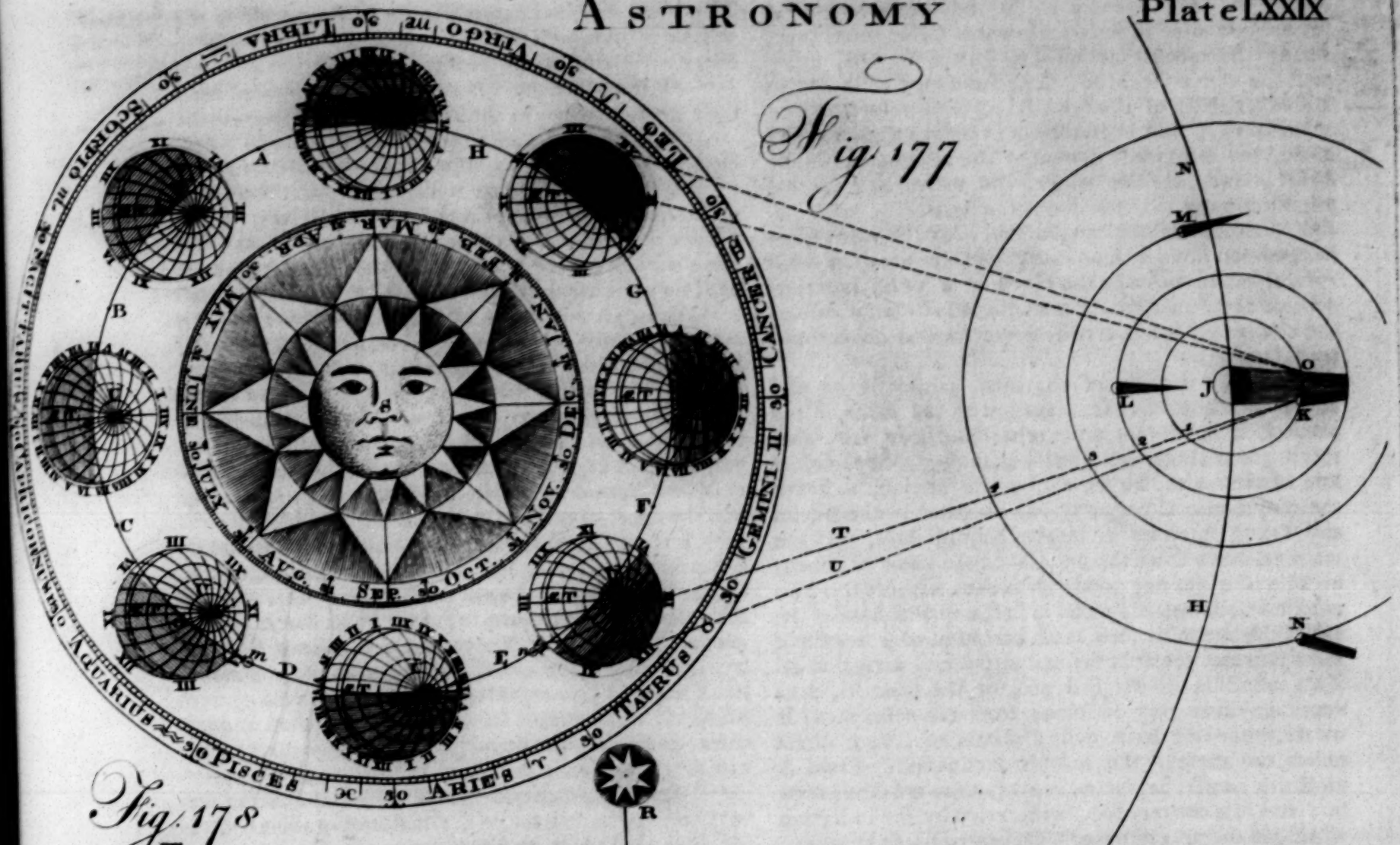


Fig. 178

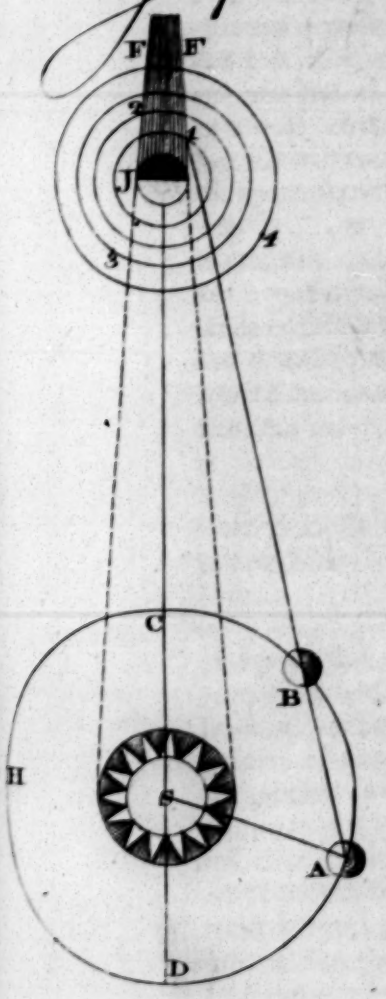


Fig. 179

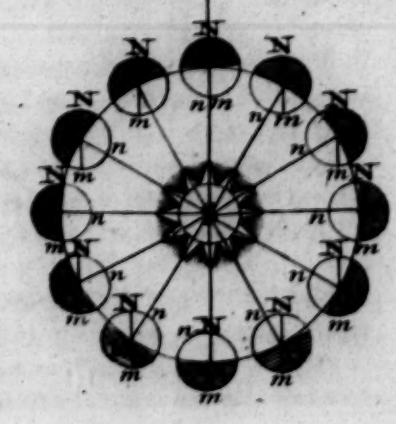
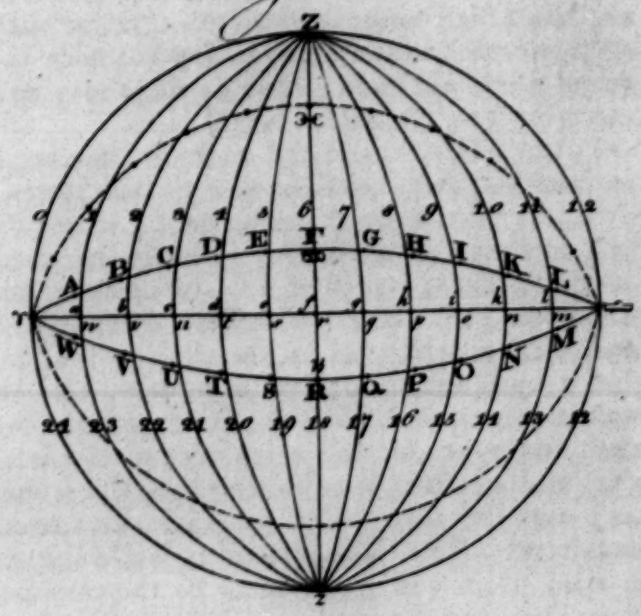


Fig. 180



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Ebbing and flowing of the Sea.

and wrote ſo amply on the ſubject, as to make the theory of the tides in a manner quite his own, by diſcovering the cauſe of their riſing on the ſide of the earth oppoſite to the moon. For Kepler believed that the preſence of the moon occaſioned an impulſe which cauſed another in her abſence.

It has been already obſerved, that the power of gravity diminiſhes as the ſquare of the diſtance increaſes; and therefore the waters at Z on the ſide of the earth ABCDEFGH next the moon M are more attracted than the central parts of the earth O by the moon, and the central parts are more attracted by her than the waters on the oppoſite ſide of the earth at *n*: and therefore the diſtance between the earth's centre and the waters on its ſurface under and oppoſite to the moon will be increaſed. For, let there be three bodies at H, O, and D: if they are all equally attracted by the body M, they will all move equally faſt toward it, their mutual diſtances from each other continuing the ſame. If the attraction of M is unequal, then that body which is moſt ſtrongly attracted will move faſteſt, and this will increaſe its diſtance from the other body. Therefore, by the law of gravitation, M will attract H more ſtrongly than it does O, by which the diſtance between H and O will be increaſed; and a ſpectator on O will perceive H riſing higher toward Z. In like manner, O being more ſtrongly attracted than D, it will move farther towards M than D does: conſequently, the diſtance between O and D will be increaſed; and a ſpectator on O, not perceiving his own motion, will ſee D receding farther from him towards *n*: all effects and appearances being the ſame, whether D recedes from O, or O from D.

Fig. 189.

Suppoſe now there is a number of bodies, as A, B, C, D, E, F, G, H, placed round O, ſo as to form a flexible or fluid ring: then, as the whole is attracted towards M, the parts at H and D will have their diſtance from O increaſed; whilſt the parts at B and F being nearly at the ſame diſtance from M as O is, theſe parts will not recede from one another; but rather, by the oblique attraction of M, they will approach nearer to O. Hence, the fluid ring will form itſelf into an ellipſe ZIBL*n*KFNZ, whoſe longer axis *n* OZ produced will paſs through M, and its ſhorter axis BOF will terminate in B and F. Let the ring be filled with fluid particles, ſo as to form a ſphere round O; then, as the whole moves towards M, the fluid ſphere being lengthened at Z and *n*, will aſſume an oblong or oval form. If M is the moon, O the earth's centre, ABC DEFGH the ſea covering the earth's ſurface, it is evident, by the above reaſoning, that whilſt the earth by its gravity falls toward the moon, the water directly below her at B will ſwell and riſe gradually towards her, alſo the water at D will recede from the centre [ſtrictly ſpeaking, the centre recedes from D], and riſe on the oppoſite ſide of the earth; whilſt the water at B and F is depreſſed, and falls below the former level. Hence as the earth turns round its axis from the moon to the moon again in 24½ hours, there will be two tides of flood and two of ebb in that time, as we find by experience.

Ebbing and flowing of the Sea.

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As this explanation of the ebbing and flowing of the ſea is deduced from the earth's conſtantly falling towards the moon by the power of gravity, ſome may find a difficulty in conceiving how this is poſſible, when the moon is full, or in oppoſition to the ſun; ſince the earth revolves about the ſun, and muſt continually fall towards it, and therefore cannot fall contrary ways at the ſame time: or if the earth is conſtantly falling towards the moon, they muſt come together at laſt. To remove this difficulty, let it be conſidered, that it is not the centre of the earth that deſcribes the annual orbit round the ſun, but the (E) common centre of gravity of the earth and moon together: and that whilſt the earth is moving round the ſun, it alſo deſcribes a circle round that centre of gravity; going as many times round it in one revolution about the ſun as there are lunations or courſes of the moon round the earth in a year: and therefore the earth is conſtantly falling towards the moon from a tangent to the circle it deſcribes round the ſaid common centre of gravity. Let M be the moon, TW part of the moon's orbit, and C the centre of gravity of the earth and moon; whilſt the moon goes round her orbit, the centre of the earth deſcribes the circle *d g e* round C, to which circle *g a k* is a tangent; and therefore when the moon has gone from M to a little paſt W, the earth has moved from *g* to *e*; and in that time has fallen towards the moon, from the tangent at *a* to *e*: and ſo on, round the whole circle.

Why the tides are high at full moon.

Fig. 190.

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The ſun's influence in raiſing the tides is but ſmall in compariſon of the moon's; for though the earth's diameter bears a conſiderable proportion to its diſtance from the moon, it is next to nothing when compared to its diſtance from the ſun. And therefore the difference of the ſun's attraction on the ſides of the earth under and oppoſite to him, is much leſs than the difference of the moon's attraction on the ſides of the earth under and oppoſite to her; and therefore the moon muſt raiſe the tides much higher than they can be raiſed by the ſun.

Influence of the ſun in raiſing tides.

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On this theory, the tides ought to be higheſt directly under and oppoſite to the moon; that is, when the moon is due north and ſouth. But we find, that in open ſeas, where the water flows freely, the Moon M is generally paſt the north and ſouth meridian, as at *p*, when it is high water at Z and at *n*. The reaſon is obvious: for though the moon's attraction was to ceaſe altogether when ſhe was paſt the meridian, yet the motion of aſcent communicated to the water before that time would make it continue to riſe for ſome time after; much more muſt it do ſo when the attraction is only diminiſhed; as a little impulſe given to a moving ball will cauſe it ſtill to move farther than otherwiſe it could

Why they are not higheſt when the moon is in the meridian.

(E) This centre is as much nearer the earth's centre than the moon's as the earth is heavier, or contains a greater quantity of matter than the moon, namely, about 40 times. If both bodies were ſuſpended on it, they would hang *in æquilibrio*. So that dividing 240,000 miles, the moon's diſtance from the earth's centre, by 40, the exceſs of the earth's weight above the moon's the quotient will be 6000 miles, which is the diſtance of the common centre of gravity of the earth and moon from the earth's centre.

Ebbing and flowing of the Sea

could have done; and as experience ſhows, that the day is hotter about three in the afternoon, than when the ſun is on the meridian, becauſe of the increaſe made to the heat already imparted.

The tides anſwer not always to the ſame diſtance of the moon from the meridian at the ſame places; but are variouſly affected by the action of the ſun, which brings them on ſooner when the moon is in her firſt and third quarters, and keeps them back later when ſhe is in her ſecond and fourth: becauſe, in the former caſe, the tide raiſed by the ſun alone would be earlier than the tide raiſed by the moon; and, in the latter caſe, later.

The moon goes round the earth in an elliptic orbit; and therefore, in every lunar month, ſhe approaches nearer to the earth than her mean diſtance, and recedes farther from it. When ſhe is neareſt, ſhe attracts ſtrongeſt, and ſo raiſes the tides moſt; the contrary happens when ſhe is fartheſt, becauſe of her weaker attraction. When both luminaries are in the equator, and the moon in perigee, or at her leaſt diſtance from the earth, ſhe raiſes the tides higheſt of all, eſpecially at her conjunction and oppoſition; both becauſe the equatorial parts have the greateſt centrifugal force from their deſcribing the largeſt circle, and from the concurring actions of the ſun and moon. At the change, the attractive forces of the ſun and moon being united, they diminiſh the gravity of the waters under the moon, and their gravity on the oppoſite ſide is diminiſhed by means of a greater centrifugal force. At the full, whilſt the moon raiſes the tide under and oppoſite to her, the ſun, acting in the ſame line, raiſes the tide under and oppoſite to him; whence their conjoint effect is the ſame as at the change; and, in both caſes, occaſion what we call the *Spring Tides*. But at the quarters the ſun's action on the waters at O and H diminiſhes the effect of the moon's action on the water at Z and N; ſo that they riſe a little under and oppoſite to the ſun at O and H, and fall as much under and oppoſite to the moon at Z and N; making what we call the *Neap Tides*, becauſe the ſun and moon then act croſs-wiſe to each other. But theſe tides happen not till ſome time after; becauſe in this, as in other caſes, the actions do not produce the greateſt effect when they are at the ſtrongeſt, but ſome time afterwards.

The ſun, being nearer the earth in winter than in ſummer, is of courſe nearer to it in February and October than in March and September; and therefore the greateſt tides happen not till ſome time after the autumnal equinox, and return a little before the vernal.

The ſea, being thus put into motion, would continue to ebb and flow for ſeveral times, even though the ſun and moon were annihilated, or their influence ſhould ceaſe; as, if a baſon of water were agitated, the water would continue to move for ſome time after the baſon was left to ſtand ſtill; or like a pendulum, which, having been put in motion by the hand, continues to make ſeveral vibrations without any new impulſe.

When the moon is in the equator, the tides are equally high in both parts of the lunar day, or time of the moon's revolving from the meridian to the meridian again, which is 24 hours 50 minutes. But as the moon declines from the equator towards either pole, the tides are alternately higher and lower at places having north or ſouth latitude. For one of the higheſt elevations, which is that under the moon, follows her towards the pole to which ſhe is neareſt, and the other declines towards the oppoſite pole; each elevat ion deſcribing parallels as far diſtant from the equator, on oppoſite ſides, as the moon declines from it to either ſide; and conſequently the parallels deſcribed by theſe elevations of the water are twice as many degrees from one another as the moon is from the equator; increaſing their diſtance as the moon increaſes her declination, till it be at the greateſt, when the ſaid parallels are, at a mean ſtate, 47 degrees from one another: and on that day, the tides are moſt unequal in their heights. As the moon returns towards the equator, the parallels deſcribed by the oppoſite elevations approach towards each other, until the moon comes to the equator, and then they coincide. As the moon declines towards the oppoſite pole, at equal diſtances, each elevation deſcribes the ſame parallel in the other part of the lunar day, which its oppoſite elevation deſcribed before. Whilſt the moon has north declination, the greateſt tides in the northern hemiſphere are when ſhe is above the horizon; and the reverſe whilſt her declination is ſouth. Let NESQ be the earth, NSC its axis, EQ the equator, T ♋ the tropic of Cancer, *t* ♑ the tropic of Capricorn, *a b* the arctic circle, *c d* the antarctic, N the north pole, S the ſouth pole, M the moon, F and G the two eminences of water, whoſe loweſt parts are at *a* and *d*, at N and S, and at *b* and *c*, always 90 degrees from the higheſt. Now, when the moon is in her greateſt north declination at M, the higheſt elevation G under her is on the tropic of Cancer T ♋, and the oppoſite elevation F on the tropic of Capricorn *t* ♑; and theſe two elevations deſcribe the tropics by the earth's diurnal rotation. All places in the northern hemiſphere ENQ have the higheſt tides when they come into the poſition *b* ♋ Q, under the moon: and the loweſt tides when the earth's diurnal rotation carries them into the poſition *a* TE, on the ſide oppoſite to the moon; the reverſe happens at the ſame time in the ſouthern hemiſphere ESQ, as is evident to ſight. The axis of the tides *a* C *d* has now its poles *a* and *d* (being always 90 degrees from the higheſt elevations) in the arctic and antarctic circles; and therefore it is plain, that at theſe circles there is but one tide of flood, and one of ebb, in the lunar day. For, when the point *a* revolves half round to *b*, in 12 lunar hours, it has a tide of flood; but when it comes to the ſame point *a* again in 12 hours more, it has the loweſt ebb. In ſeven days afterward, the moon M comes to the equinoctial circle, and is over the equator EQ, when both elevations deſcribe the equator; and in both hemiſpheres, at equal diſtances from the equator, the tides are equally high in both parts of the lunar day. The whole phenomena being reverſed, when the moon has ſouth declination, to what they were when her declination was north, require no farther deſcription. Fig. 192, 193, 194.

In the three laſt-mentioned figures, the earth is orthographically projected on the plane of the meridian; but in order to deſcribe a particular phenomenon, we now project it on the plane of the ecliptic. Let HZON be the earth and ſea, FED the equator, T the tropic of Cancer, C the arctic circle, P the north pole, and the curves, 1, 2, 3, &c. 24 meridians or Fig. 191.

Ebbing and flowing of the Sea.

Ebbing and flowing of the Sea.

hour-circles, interſecting each other in the poles; AGM is the moon's orbit, S the ſun, M the moon, Z the water elevated under the moon, and N the oppoſite equal elevation. As the loweſt parts of the water are always 90 degrees from the higheſt, when the moon is in either of the tropics (as at M), the elevation Z is on the tropic of Capricorn, and the oppoſite elevation N on the tropic of Cancer; the low-water circle HCO touches the polar circles at C; and the high-water circle ETP6 goes over the poles at P, and divides every parallel of latitude into two equal ſegments. In this caſe, the tides upon every parallel are alternately higher and lower; but they return in equal times: the point T, for example, on the tropic of Cancer (where the depth of the tide is repreſented by the breadth of the dark ſhade), has a ſhallower tide of flood at T than when it revolves half round from thence to 6, according to the order of the numeral figures; but it revolves as ſoon from 6 to T as it did from T to 6. When the moon is in the equinoctial, the elevations Z and N are tranſferred to the equator at O and H, and the high and low-water circles are got into each other's former places; in which caſe the tides return in unequal times, but are equally high in both parts of the lunar day: for a place at 1 (under D) revolving as formerly, goes ſooner from 1 to 11 (under F) than from 11 to 1, becauſe the parallel it deſcribes is cut into unequal ſegments by the high water circle HCO: but the points 1 and 11 being equidiſtant from the pole of the tides at C, which is directly under the pole of the moon's orbit MGA, the elevations are equally high in both parts of the day.

367 Tides turn on the axis of the moon's orbit.

And thus it appears, that as the tides are governed by the moon, they muſt turn on the axis of the moon's orbit, which is inclined 23½ degrees to the earth's axis at a mean ſtate: and therefore the poles of the tides muſt be ſo many degrees from the poles of the earth, or in oppoſite points of the polar circles, going round theſe circles in every lunar day. It is true, that according to fig. 194. when the moon is vertical to the equator ECQ, the poles of the tides ſeem to fall in with the poles of the world N and S: but when we conſider that FGH is under the moon's orbit, it will appear, that when the moon is over H, in the tropic of Capricorn, the north pole of the tides (which can be no more than 90 degrees from under the moon) muſt be at C in the arctic circle, not at P the north pole of the earth; and as the moon aſcends from H to G in her orbit, the north pole of the tides muſt ſhift from *c* to *a* in the arctic circle, and the ſouth poles as much in the antarctic.

It is not to be doubted, but that the earth's quick rotation brings the poles of the tides nearer to the poles of the world, than they would be if the earth were at reſt and the moon revolved about it only once a month; for otherwiſe the tides would be more unequal in their heights and times of their return, than we find they are. But how near the earth's rotation may bring the poles of its axis and thoſe of the tides together, or how far the preceding tides may affect thoſe which follow, ſo as to make them keep up nearly to the ſame heights and times of ebbing and flowing, is a problem more fit to be ſolved by obſervation than by theory.

Thoſe who have opportunity to make obſervations, and chooſe to ſatisfy themſelves whether the tides are really affected in the above manner by the different poſitions of the moon, eſpecially as to the unequal times of their returns, may take this general rule for knowing when they ought to be ſo affected. When the earth's axis inclines to the moon, the northern tides, if not retarded in their paſſage through ſhoals and channels, nor affected by the winds, ought to be greateſt when the moon is above the horizon, leaſt when ſhe is below it; and quite the reverſe when the earth's axis declines from her: but in both caſes, at equal intervals of time. When the earth's axis inclines ſidewiſe to the moon, both tides are equally high, but they happen at unequal intervals of time. In every lunation the earth's axis inclines once to the moon, once from her, and twice ſidewiſe to her, as it does to the ſun every year; becauſe the moon goes round the ecliptic every month, and the ſun but once in a year. In ſummer, the earth's axis inclines towards the moon when new; and therefore the day-tides in the north ought to be higheſt, and night-tides loweſt, about the change: at the full, the reverſe. At the quarters, they ought to be equally high, but unequal in their returns; becauſe the earth's axis then inclines ſidewiſe to the moon. In winter, the phenomena are the ſame at full moon as in ſummer at new. In autumn, the earth's axis inclines ſidewiſe to the moon when new and full; therefore, the tides ought to be equally high and uneven in their returns at theſe times. At the firſt quarter, the tides of flood ſhould be leaſt when the moon is above the horizon, greateſt when ſhe is below it: and the reverſe at her third quarter. In ſpring, the phenomena of the firſt quarter anſwer to thoſe of the third quarter in autumn; and *vice verſa*. The nearer any time is to either of theſe ſeaſons, the more the tides partake of the phenomena of theſe ſeaſons; and in the middle between any two of them the tides are at a mean ſtate between thoſe of both.

In open ſeas, the tides riſe but to very ſmall heights in proportion to what they do in wide-mouthed rivers, opening in the direction of the ſtream of tide. For in channels growing narrower gradually, the water is accumulated by the oppoſition of the contracting bank: like a gentle wind, little felt on an open plane, but ſtrong and briſk in a ſtreet; eſpecially if the wider end of the ſtreet be next the plain, and in the way of the wind.

268 Irregularities of tides accounted for.

The tides are ſo retarded in their paſſage thro' different ſhoals and channels, and otherwiſe ſo variouſly affected by ſtriking againſt capes and headlands, that to different places they happen at all diſtances of the moon from the meridian, conſequently at all hours of the lunar day. The tide propagated by the moon in the German ocean, when ſhe is three hours paſt the meridian, takes 12 hours to come from thence to London bridge; where it arrives by the time that a new tide is raiſed in the ocean. And therefore, when the moon has north declination, and we ſhould expect the tide at London to be greateſt when the moon is above the horizon, we find it is leaſt; and the contrary when ſhe has ſouth declination. At ſeveral places it is high-water three hours before the moon comes to the meridian; but that tide which the moon puſhes as it were before her, is only the tide oppoſite to that which was raiſed by her when ſhe was nine hours paſt the oppoſite meridian.

There are no tides in lakes, becauſe they are gene-

Ebbing and flowing of the Sea.

rally ſo ſmall, that when the moon is vertical ſhe attracts every part of them alike, and therefore by rendering all the water equally light, no part of it can be raiſed higher than another. The Mediterranean and Baltic ſeas have very ſmall elevations, becauſe the inlets by which they communicate with the ocean are ſo narrow, that they cannot, in ſo ſhort a time, receive or diſcharge enough to raiſe and ſink their ſurfaces ſenſibly.

369 Why the moon does not affect the barometer.

Air being lighter than water, and the ſurface of the atmoſphere being nearer to the moon than the ſurface of the ſea, it cannot be doubted that the moon raiſes much higher tides in the air than in the ſea. And therefore many have wondered why the mercury does not ſink in the barometer when the moon's action on the particles of air makes them lighter as ſhe paſſes over the meridian. But we muſt conſider, that as theſe particles are rendered lighter, a greater number of them are accumulated, until the deficiency of gravity be made up by the height of the column; and then there is an equilibrium, and conſequently an equal preſſure upon the mercury as before; ſo that it cannot be affected by the aerial tides. It is very probable, however, that the ſtars which are ſeen through an aerial tide of this kind will have their light more refracted than thoſe which are ſeen through the common depth of the atmoſphere; and this may account for the ſuppoſed refractions by the lunar atmoſphere that have been ſometimes obſerved.

370 Of the harveſt moon.

It is generally believed that the moon riſes about 50 minutes later every day than on the preceding; but this is true only with regard to places on the equator. In places of conſiderable latitude there is a remarkable difference, eſpecially in the harveſt time. Here the autumnal full moon riſes very ſoon after ſun-ſet for ſeveral evenings together. At the polar circles, where the mild ſeaſon is of very ſhort duration, the autumnal full moon riſes at ſun-ſet from the firſt to the third quarter. And at the poles, where the ſun is for half a year abſent, the winter full-moons ſhine conſtantly without ſetting from the firſt to the third quarter.

All theſe phenomena are owing to the different angles made by the horizon and different parts of the moon's orbit; and may be explained in the following manner.

The plane of the equinoctial is perpendicular to the earth's axis; and therefore as the earth turns round its axis, all parts of the equinoctial make equal angles with the horizon both at riſing and ſetting: ſo that equal portions of it always riſe or ſet in equal times. Conſequently, if the moon's motions were equable, and in the equinoctial, at the rate of 12 degrees 11 min. from the ſun every day, as it is in her orbit, ſhe would riſe and ſet 50 minutes later every day than on the preceding: for 12 deg. 11 min. of the equinoctial riſe or ſet in 50 minutes of time in all latitudes.

But the moon's motion is ſo nearly in the ecliptic, that we may conſider her at preſent as moving in it. Now the different parts of the ecliptic, on account of its obliquity to the earth's axis, make very different angles with the horizon as they riſe or ſet. Thoſe parts or ſigns which riſe with the ſmalleſt angles ſet with the greateſt, and *vice verſa*. In equal times, whenever this angle is leaſt, a greater portion of the ecliptic riſes than when the angle is larger; as may be ſeen by elevating the pole of a globe to any conſiderable latitude, and then turning it round its axis in the horizon. Conſequently, when the moon is in thoſe ſigns which riſe or ſet with the ſmalleſt angles, ſhe riſes or ſets with the leaſt difference of time; and with the greateſt difference in thoſe ſigns which riſe or ſet with the greateſt angles.

Ebbing and flowing of the Sea.

Let FUP be the axis of a globe, ♋ TR the tropic of Cancer, L♑ the tropic of Capricorn, ♋ EU ♑ the ecliptic touching both the tropics, which are 47 degrees from each other, and AB the horizon. The equator, being in the middle between the tropics, is cut by the ecliptic into two oppoſite points, which are the beginnings of Aries and Libra, K is the hour-circle with its index, F the north pole of the globe elevated to a conſiderable latitude, ſuppoſe 40 degrees above the horizon; and P the ſouth pole depreſſed as much below it. Becauſe of the oblique poſition of the ſphere in this latitude, the ecliptic has the high elevation N ♋ above the horizon, making the angle NU ♋ of 73½ degrees with it when Cancer is on the meridian, at which time Libra riſes in the eaſt. But let the globe be turned half round it axis, till Capricorn comes to the meridian and Aries riſes in the eaſt; and then the ecliptic will have the low elevation NL above the horizon, making only an angle NUL of 26½ degrees with it; which is 47 degrees leſs than the former angle, equal to the diſtance between the tropics. Fig. 187.

In Northern latitudes, the ſmalleſt angle made by the ecliptic and horizon is when Aries riſes, at which time Libra ſets; the greateſt when Libra riſes, at which time Aries ſets. From the riſing of Aries to the riſing of Libra (which is twelve (A) ſidereal hours) the angle increaſes; and from the riſing of Libra to the riſing of Aries, it decreaſes in the ſame proportion. By this article and the preceding, it appears, that the ecliptic riſes faſteſt about Aries, and ſloweſt about Libra.

On the parallel of London, as much of the ecliptic riſes about Piſces and Aries in two hours as the moon goes through in ſix days: and therefore, whilſt the moon is in theſe ſigns, ſhe differs but two hours in riſing for ſix days together; that is, about 20 minutes later every day or night than on the preceding, at a mean rate, But in 14 days afterwards the moon comes to Virgo and Libra, which are the oppoſite ſigns to Piſces and Aries; and then ſhe differs almoſt four times as much in riſing; namely, one hour and about fifteen minutes later every day or night than the former, whilſt ſhe is in theſe ſigns.

As the moon can never be full but when ſhe is oppoſite to the ſun, and the ſun is never in Virgo and Libra but in our autumnal months, it is plain that the moon

(A) The ecliptic, together with the fixed ſtars, make 366¼ apparent diurnal revolutions about the earth in a year; the ſun only 365¼. Therefore the ſtars gain 3 minutes 56 ſeconds upon the ſun every day: ſo that a ſidereal day contains only 23 hours 56 minutes of mean ſolar time, and a natural or ſolar day 24 hours. Hence 12 ſidereal hours are 11 minutes 58 ſeconds ſhorter than 12 ſolar.

ASTRONOMY

Plate LXXX

Fig. 181

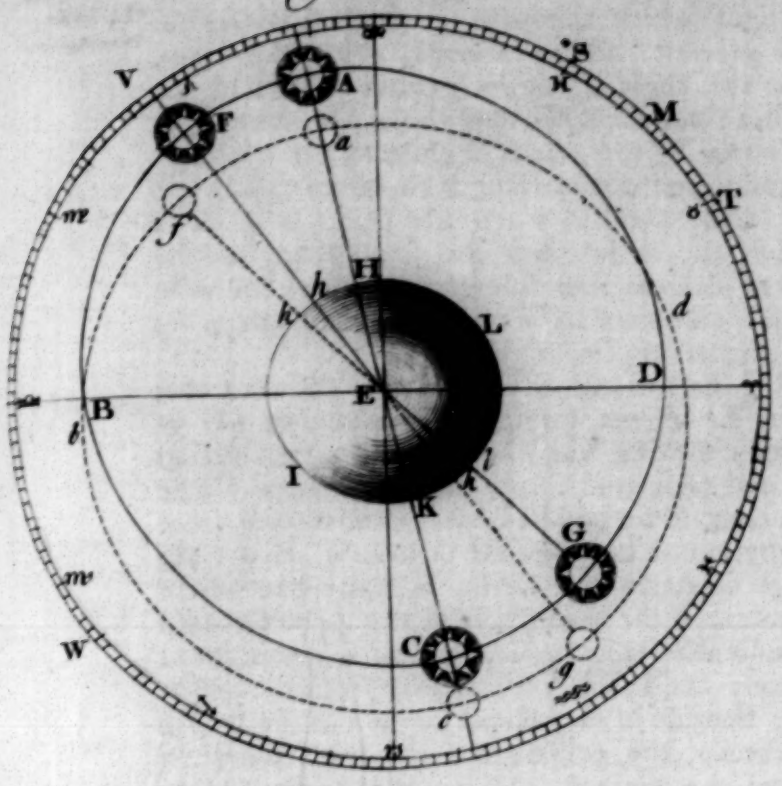


Fig. 182

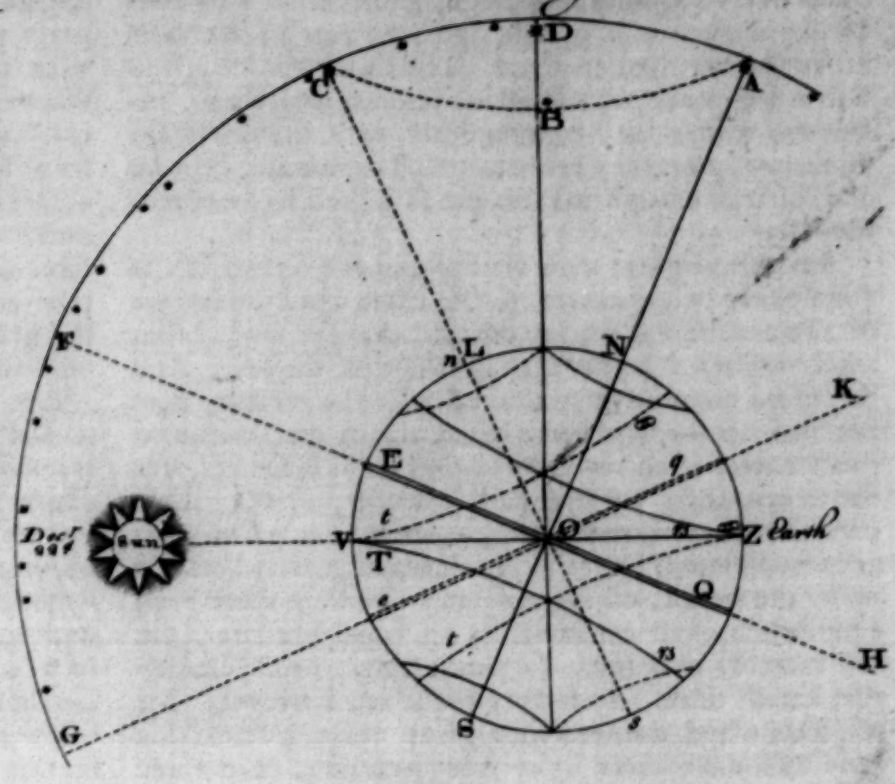


Fig. 183

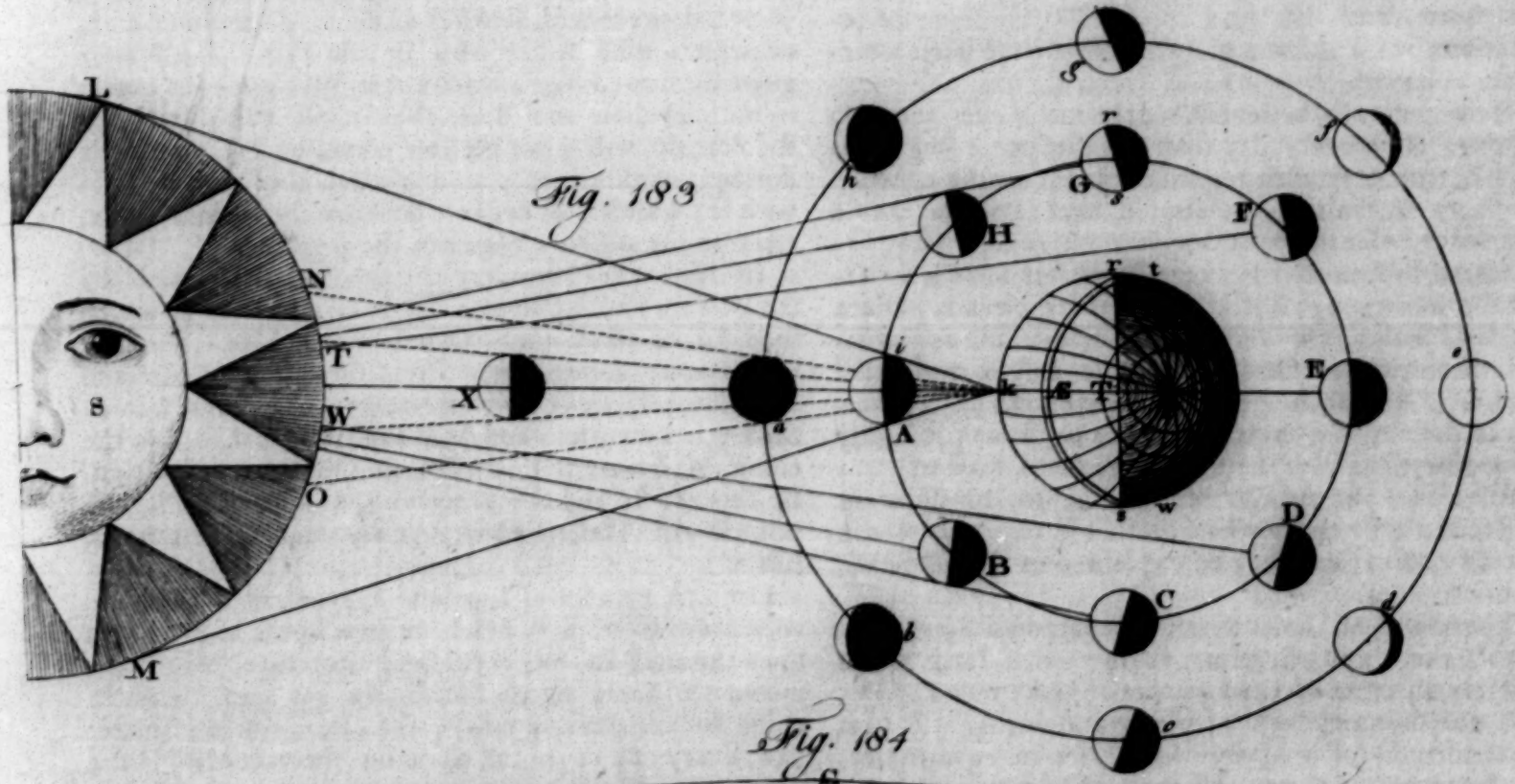


Fig. 184

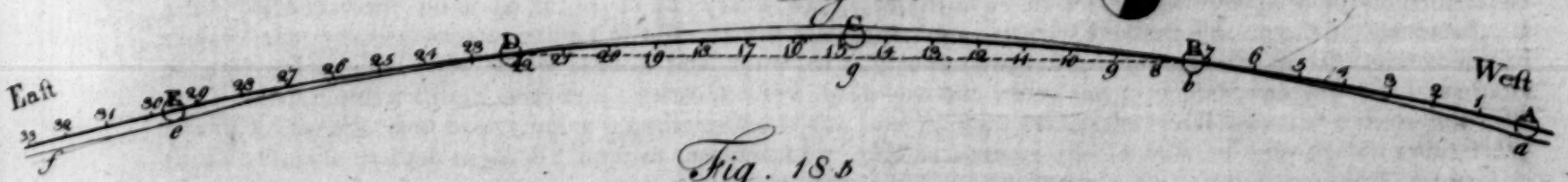
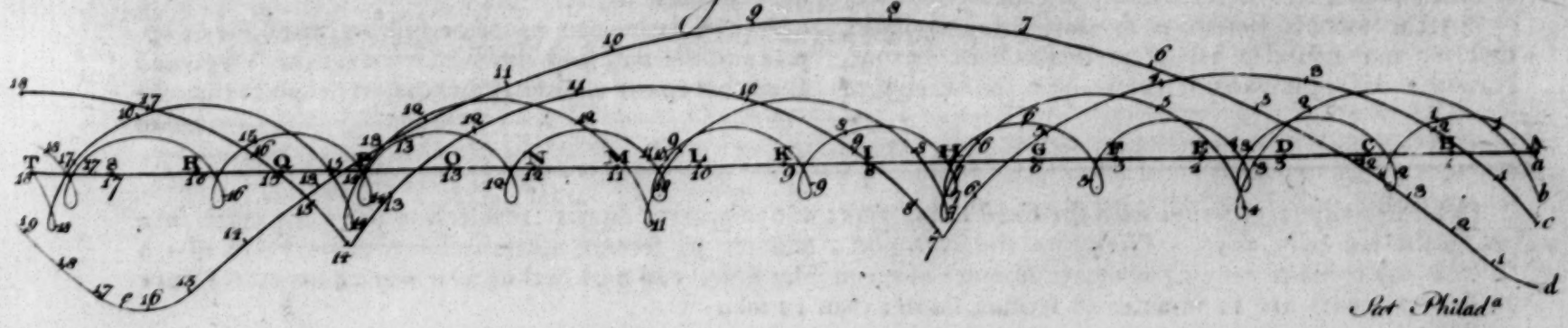


Fig. 185



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Harveſt and Horizontal Moon.

moon is never full in the oppoſite ſigns, Piſces and Aries, but in thoſe two months. And therefore we can have only two full moons in the year, which riſe ſo near the time of ſun-ſet for a week together as abovementioned. The former of theſe is called the *harveſt moon*, and the latter the *hunter's moon*.

371 Why the ſame phenomenon is not obſerved at other times.

Here it will probably be aſked, why we never obſerve this remarkable riſing of the moon but in harveſt, ſeeing ſhe is in Piſces and Aries twelve times in the year beſides; and muſt then riſe with as little difference of time as in harveſt? The anſwer is plain; for in winter theſe ſigns riſe at noon; and being then only a quarter of a circle diſtant from the ſun, the moon in them is in her firſt quarter: but when the ſun is above the horizon, the moon's riſing is neither regarded nor perceived. In ſpring, theſe ſigns riſe with the ſun, becauſe he is then in them; and as the moon changeth in them at that time of the year, ſhe is quite inviſible. In ſummer they riſe about midnight; and the ſun being then three ſigns, or a quarter of a circle, before them, the moon is in them about her third quarter; when riſing ſo late, and giving but very little light, her riſing paſſes unobſerved. And in autumn, theſe ſigns, being oppoſite to the ſun, riſe when he ſets, with the moon in oppoſition, or at the full, which makes her riſing very conſpicuous.

At the equator, the north and ſouth poles lie in the horizon; and therefore the ecliptic makes the ſame angle ſouthward with the horizon when Aries riſes, as it does northward when Libra riſes, Conſequently, as the moon riſes and ſets nearly at equal angles with the horizon all the year round, and about 50 minutes later every day or night than on the preceding, there can be no particular harveſt-moon at the equator.

The farther that any place is from the equator, if it be not beyond the polar circle, the more the angle is diminiſhed which the ecliptic and horizon make when Piſces and Aries riſe: and therefore when the moon is in theſe ſigns, ſhe riſes with a nearly proportionable difference later every day than on the former; and is for that reaſon the more remarkable about the full, until we come to the polar circles, or 66 degrees from the equator; in which latitude the ecliptic and horizon become coincident every day for a moment, at the ſame ſidereal hour (or 3 minutes 56 ſeconds ſooner every day than the former), and the very next moment one half of the ecliptic, containing Capricorn, Aquarius, Piſces, Aries, Taurus, and Gemini, riſes, and the oppoſite half ſets. Therefore, whilſt the moon is going from the beginning of Capricorn to the beginning of Cancer, which is almoſt 14 days, ſhe riſes at the ſame ſidereal hour; and in autumn juſt at ſun-ſet, becauſe all that half of the ecliptic, in which the ſun is at that time, ſets at the ſame ſidereal hour, and the oppoſite half riſes; that is, 3 minutes 56 ſeconds of mean ſolar time, ſooner every day than on the day before. So whilſt the moon is going from Capricorn to Cancer, ſhe riſes earlier every day than on the preceding; contrary to what ſhe does at all places between the polar circles. But during the above 14 days, the moon is 24 ſidereal hours later in ſetting: for the ſix ſigns which riſe all at once on the eaſtern ſide of the horizon are 24 hours in ſetting on the weſtern ſide of it.

In northern latitudes the autumnal full moons are in Piſces and Aries, and the vernal full moons in Virgo and Libra; in ſouthern latitudes, juſt the reverſe, becauſe the ſeaſons are contrary. But Virgo and Libra riſe at as ſmall angles with the horizon in ſouthern latitudes, as Piſces and Aries do in the northern; and therefore the harveſt-moons are juſt as regular on one ſide of the equator as on the other.

Harveſt and Horizontal Moon.

As theſe ſigns, which riſe with the leaſt angles, ſet with the greateſt, the vernal full moons differ as much in their times of riſing every night as the autumnal full moons differ in their times of ſetting; and ſet with as little difference as the autumnal full moons riſe; the one being in all caſes the reverſe of the other.

Hitherto, for the ſake of plainneſs, we have ſuppoſed the moon to move in the ecliptic, from which the ſun never deviates. But the orbit in which the moon really moves is different from the ecliptic; one half being elevated 5½ degrees above it, and the other half as much depreſſed below it. The moon's orbit therefore interſects the ecliptic in two points diametrically oppoſite to each other; and theſe interſections are called the *Moon's Nodes*. So the moon can never be in the ecliptic but when ſhe is in either of her nodes, which is at leaſt twice every courſe from change to change, and ſometimes thrice: For, as the moon goes almoſt a whole ſign more than around her orbit from change to change; if ſhe paſſes by either node about the time of change, ſhe will paſs by the other in about 14 days after, and come round to the former node two days again before the next change. That node from which the moon begins to aſcend northward, or above the ecliptic, in northern latitudes, is called the *Aſcending Node*; and the other the *Deſcending Node*, becauſe the moon, when ſhe paſſes by it, deſcends below the ecliptic ſouthward.

The moon's oblique motion with regard to the ecliptic cauſes ſome difference in the times of her riſing and ſetting from what is already mentioned. For when ſhe is northward of the ecliptic, ſhe riſes ſooner and ſets later than if ſhe moved in the ecliptic: and when ſhe is ſouthward of the ecliptic, ſhe riſes later and ſets ſooner. This difference is variable, even in the ſame ſigns, becauſe the nodes ſhift backward about 19½ degrees in the ecliptic every year; and ſo go round it contrary to the order of the ſigns in 18 years 225 days.

When the aſcending node is in Aries, the ſouthern half of the moon's orbit makes an angle of 5½ degrees leſs with the horizon than the ecliptic does, when Aries riſes in northern latitudes: for which reaſon the moon riſes with leſs difference of time whilſt ſhe is in Piſces and Aries, than ſhe would do if ſhe kept in the ecliptic. But in 9 years and 112 days afterward, the deſcending node comes to Aries; and then the moon's orbit makes an angle 5½ degrees greater with the horizon when Aries riſes, than the ecliptic does at that time; which cauſes the moon to riſe with greater difference of time in Piſces and Aries than if ſhe moved in the ecliptic.

To be a little more particular: When the aſcending node is in Aries, the angle is only 9½ degrees on the parallel of London when Aries riſes; but when the deſcending node comes to Aries, the angle is 20½ degrees. This occaſions as great a difference of the moon's

Harveſt and Horizontal Moon.

moon's riſing in the ſame ſigns every nine years, as there would be on two parallels 10½ degrees from one another, if the moon's courſe were in the ecliptic.

372 Revolution of the moon's nodes.

As there is a complete revolution of the nodes in 18½ years, there muſt be a regular period of all the varieties which can happen in the riſing and ſetting of the moon during that time. But this ſhifting of the nodes never affects the moon's riſing ſo much, even in her quickeſt deſcending latitude, as not to allow us ſtill the benefit of her riſing nearer the time of ſun-ſet for a few days together about the full in harveſt, than when ſhe is full at any other time of the year.

373 Long moon-light in winter at the poles.

At the polar circles, when the ſun touches the ſummer tropic, he continues 24 hours above the horizon; and 24 hours below it, when he touches the winter tropic. For the ſame reaſon, the full moon neither riſes in ſummer nor ſets in winter, conſidering her as moving in the ecliptic. For the winter full moon being as high in the ecliptic as the ſummer ſun, muſt therefore continue as long above the horizon; and the ſummer full moon being as low in the ecliptic as the winter ſun, can no more riſe than he does. But theſe are only the two full moons which happen about the tropics, for all the others riſe and ſet. In ſummer, the full moons are low, and their ſtay is ſhort above the horizon, when the nights are ſhort, and we have leaſt occaſion for moon light: in winter they go high, and ſtay long above the horizon, when the nights are long, and we want the greateſt quantity of moonlight.

At the poles, one half of the ecliptic never ſets, and the other half never riſes: and therefore, as the ſun is always half a year in deſcribing one half of the ecliptic, and as long in going through the other half, it is natural to imagine that the ſun continues half a year together above the horizon of each pole in its turn, and as long below it; riſing to one pole when he ſets to the other. This would be exactly the caſe if there were no refraction: but by the atmoſphere's refracting the ſun's rays, he becomes viſible ſome days ſooner, and continues ſome days longer in ſight, than he would otherwiſe do: ſo that he appears above the horizon of either pole before he has got below the horizon of the other. And, as he never goes more than 23½ degrees below the horizon of the poles, they have very little dark night; it being twilight there, as well as at other places, till the ſun be 18 degrees below the horizon. The full moon, being always oppoſite to the ſun, can never be ſeen while the ſun is above the horizon, except when ſhe is in the northern half of her orbit; for whenever any point of the ecliptic riſes, the oppoſite point ſets. Therefore, as the ſun is above the horizon of the north pole from the 20th of March till 23d of September, it is plain that the moon, when full, being oppoſite to the ſun, muſt be below the horizon during that half of the year. But when the ſun is in the ſouthern half of the ecliptic, he never riſes to the north pole; during which half of the year, every full moon happens in ſome part of the northern half of the ecliptic which never ſets. Conſequently, as the polar inhabitants never ſee the full moon in ſummer, they have her always in the winter, before, at, and after, the full, ſhining for 14 of our days and nights. And when the ſun is at his greateſt depreſſion below the horizon, being then in Capricorn, the moon is at her third quarter in Aries, full in Cancer, and at her firſt quarter in Libra. And as the beginning of Aries is the riſing point of the ecliptic, Cancer the higheſt, and Libra the ſetting point, the moon riſes at her firſt quarter in Aries; is moſt elevated above the horizon, and full, in Cancer; and ſets at the beginning of Libra, in her third quarter, having continued viſible for 14 diurnal rotations of the earth. Thus the poles are ſupplied one-half of the winter-time with conſtant moon-light in the ſun's abſence; and only loſe ſight of the moon from her third to her firſt quarter, while ſhe gives but very little light and could be but of little and ſometimes of no ſervice to them. A bare view of the figure will make this plain: in which let S be the ſun; e, the earth in ſummer, when its north pole *n* inclines towards the ſun; and E the earth in winter, when its north pole declines from him. SEN and NWS is the horizon of the north pole, which is coincident with the equator,; and, in both theſe poſitions of the earth, ♈ ♎ ♎ ♍ is the moon's orbit, in which ſhe goes round the earth, according to the order of the letters *a b c d*, A B C D. When the moon is at *a* ſhe is in her third quarter to the earth at e, and juſt riſing to the north pole *n*; at *b* ſhe changes, and is at the greateſt height above the horizon, as the ſun likewiſe is; at *c* ſhe is in her firſt quarter, ſetting below the horizon; and is loweſt of all under it at *d*, when oppoſite to the ſun, and her enlightened ſide toward the earth. But then ſhe is full in view to the ſouth pole *p*: which is as much turned from the ſun as the north pole inclines toward him. Thus, in our ſummer, the moon is above the horizon of the north pole whilſt ſhe deſcribes the northern half of the ecliptic ♈ ♋ ♎, or from her third quarter to her firſt; and below the horizon during her progreſs through the ſouthern half ♎ ♍ ♈; higheſt at the change, moſt depreſſed at the full. But in winter, when the earth is at E, and its north pole declines from the ſun, the new moon at D is at her greateſt depreſſion below the horizon NWS, and the full moon at B at her greateſt height above it; riſing at her firſt quarter A, and keeping above the horizon till ſhe comes to her third quarter C. At a mean ſtate ſhe is 23½ degrees above the horizon at B and *b*, and as much below it at D and *d*, equal to the inclination of the earth's axis F. S ♋, or S ♑, are, as it were, a ray of light proceeding from the ſun to the earth; and ſhows that when the earth is at e, the ſun is above the horizon, vertical to the tropic of Cancer; and when the earth is at E, he is below the horizon, vertical to the tropic of Capricorn.

Harveſt and Horizontal Moon.

Fig. 188.

374 Horizontal moon accounted for by Mr Ferguſon.

The ſun and moon generally appear larger when near the horizon than when at a diſtance from it; for which there have been various reaſons aſſigned. The following account is given by Mr Ferguſon: "Theſe luminaries although at great diſtances from the earth, appear floating as it were on the ſurface of our atmoſphere, HGF*f*cC, a little way beyond the clouds; of which, thoſe about F, directly over our heads at E, are nearer us than thoſe about H or c in the horizon HEc. Therefore, when the ſun or moon appear in the horizon at *e*, they are not only ſeen in a part of the ſky which is really farther from us than if they were at any conſiderable altitude, as about *f*; but they are alſo ſeen through a greater quantity of air and vapours at c than at *f*. Here we have two concurring appear-

Fig. 170.

ances

Harveſt and Horizontal Moon.

ances which deceive our imagination, and cauſe us to refer the ſun and moon to a greater diſtance at their riſing or ſetting about c, than when they are conſiderably high, as at *f*: firſt, their ſeeming to be on a part of the atmoſphere at c, which is really farther than *f* from a ſpectator at E; and, ſecondly, their being ſeen through a groſſer medium when at c than when at *f*, which, by rendering them dimmer, cauſes us to imagine them to be at a yet greater diſtance. And as, in both caſes, they are ſeen much under the ſame angle, we naturally judge them to be largeſt when they ſeem fartheſt from us.

"Any one may ſatisfy himſelf that the moon appears under no greater angle in the horizon than on the meridian, by taking a large ſheet of paper, and rolling it up in the form of a tube, of ſuch a width, that, obſerving the moon through it when ſhe riſes, ſhe may as it were juſt fill the tube; then tie a thread round it to keep it of that ſize; and when the moon comes to the meridian, and appears much leſs to the eye, look at her again through the ſame tube, and ſhe will fill it juſt as much, if not more, than ſhe did at her riſing.

"When the full moon is in her perigee, or at her leaſt diſtance from the earth, ſhe is ſeen under a larger angle, and muſt therefore appear bigger than when ſhe is full at other times: And if that part of the atmoſphere where ſhe riſes be more replete with vapours than uſual, ſhe appears ſo much the dimmer; and therefore we fancy her to be ſtill the bigger, by referring her to an unuſually great diſtance, knowing that no objects which are very far diſtant can appear big unleſs they really be ſo."

375 By Mr Dunn.

To others this ſolution has appeared unſatisfactory; and accordingly Mr Dunn has given the following diſſertation on this phenomenon, Phil. Tranſ. Vol. LXIV.

"1. The ſun and moon, when they are in or near the horizon, appear to the naked eye of the generality of perſons, ſo very large in compariſon with their apparent magnitudes when they are in the zenith, or ſomewhat elevated, that ſeveral learned men have been led to inquire into the cauſe of this phenomenon; and after endeavouring to find certain reaſons, founded on the principles of phyſics, they have at laſt pronounced this phenomenon a mere optical illuſion.

"2. The principal diſſertations which I have ſeen conducing to give any information on this ſubject, or helping to throw any light on the ſame, have been thoſe printed in the Tranſactions of the Royal Society, the Academy of Sciences at Paris, the German Acts, and Dr Smith's Optics; but as all the accounts which I have met with in theſe writings any way relative to this ſubject, have not given me that ſatisfaction which I have deſired, curioſity has induced me to inquire after the cauſe of this ſingular phenomenon in a manner ſomewhat different from that which others have done before me, and by ſuch experiments and obſervations as have appeared to me pertinent; ſome of which have been as follows, viz.

"3. I have obſerved the riſing and ſetting ſun near the viſible horizon, and near riſing grounds elevated above the viſible horizon about half a degree, and found him to appear largeſt when near to the viſible horizon; and particularly a conſiderable alteration of his magnitude and light has always appeared to me from the time of his being in the horizon at riſing, to the time of his being a degree or two above the horizon, and the contrary at his ſetting; which property I have endeavoured to receive as a prejudice, and an impoſition on my ſight and judgment, the uſual reaſons for this appearance.

Harveſt and Horizontal Moon.

"4. I have alſo obſerved that the ſun near the horizon appears to put on the figure of a ſpheroid, having its vertical diameter appearing to the naked eye ſhorter than the horizontal diameter; and, by meaſuring thoſe diameters in a teleſcope, have found the vertical one ſhorter than the other.

"5. I have made frequent obſervations and compariſons of the apparent magnitude of the ſun's diſk, with objects directly under him, when he has been near the horizon, and with ſuch objects as I have found by meaſurement to be of equal breadth with the ſun's diameter; but in the ſudden tranſition of the eye from the ſun to the object, and from the object to the ſun, have always found the ſun to appear leaſt; and that when two right lines have been imaginarily produced by the ſides of thoſe equal magnitudes, they have not appeared to keep parallel, but to meet beyond the ſun.

"6. From theſe and other like circumſtances, I firſt began to ſuſpect that a ſudden dip of the ſun into the horizontal vapours, might ſome how or other be the cauſe of a ſudden apparent change of magnitude; although the horizontal vapours had been diſallowed to be able to produce any other than a refraction in a vertical direction; and, reducing things to calculation, found, that from the time when the ſun is within a diameter or two of the horizon, to the time when he is a ſemidiameter below the horizon, the ſun's rays become paſſable through ſuch a length of medium, reckoning in the direction of the rays, that the total quantity of medium (reckoning both depth and denſity) through which the rays paſs, being compared with the like total depth and denſity through which they paſs at ſeveral elevations, it was proportionable to the difference of apparent magnitude, as appearing to the naked eye.

"7. This circumſtance of ſudden increaſe and decreaſe of apparent magnitude, and as ſudden decreaſe and increaſe of light (for they both go together), ſeemed to me no improbable cauſe of the phenomenon, although I could not then perceive how ſuch vapours might contribute towards enlarging the diameter of the ſun in a horizontal direction.

"8. I therefore examined the ſun's diſk again and again, by the naked eye and by teleſcopes, at different altitudes; and, among ſeveral circumſtances, found the ſolar maculæ to appear larger and plainer to the naked eye, and through a teleſcope, the ſun being near the horizon, than they had appeared the ſame days when the ſun was on the meridian, and to appearance more ſtrongly defined, yet obſcured.

"9. A little before ſun-ſetting, I have often ſeen the edge of the ſun with ſuch protuberances and indentures as have rendered him in appearance a very odd figure; the protuberances ſhooting out far beyond, and the indentures preſſing into the diſk of the ſun; and always, through a teleſcope magnifying 55 times, the the lower limb has appeared with a red glowing arch beneath it, and cloſe to the edge of the ſun, while the other parts have been clear.

"10. At

Harveſt and Horizontal Moon.

" 10. At ſun-ſetting, theſe protuberances and indentures have appeared to ſlide along the vertical limbs, from the lower limb to the higher, and their vaniſhing, ſo as often to form a ſegment of the ſun's upper limb apparently ſeparated from the diſk for a ſmall ſpace of time.

" 11. At ſun-riſing I have ſeen the like protuberances, indentures and ſlices, above deſcribed; but with this difference of motion, that at ſun-riſing they firſt appear to riſe in the ſun's upper limb, and ſlide or move downward to the lower limb; or which is the ſame thing, they always appear at the riſing and ſetting of the ſun, to keep in the ſame parallels of altitude by the teleſcope. This property has been many times ſo diſcernable, even by the naked eye, that I have obſerved the ſun's upper limb to ſhoot out towards right and left, and move downwards, forming the upper part of the diſk an apparent portion of a leſſer ſpheroid than the lower part at riſing, and the contrary at ſetting. Through the teleſcope this has appeared more plain in proportion to the power of magnifying.

" 11. Theſe protuberances and indentures ſo eaſily meaſurable by the micrometer, whilſt the teleſcope wires appeared ſtrait, enabled me to conclude, that certain ſtrata of the atmoſphere have different refractive powers; and, lying horizontally acroſs the conical or cycloidal ſpace traced out by the rays between the eye and that part of the atmoſphere firſt touched by the rays, muſt have been the cauſe of ſuch apparent protuberances and indentures in an horizontal direction acroſs the ſun's vertical limbs; and alſo that the bottoms of thoſe protuberances and indentures muſt be conſiderably enlarged, and removed to appearance farther from the centre of the diſk than they would have been had there been no ſuch ſtrata to refract.

" 13. Before ſun-riſing, when the ſun has been near the tropic; and the ſky, at the utmoſt extent of the horizon which appeared very clear; and when certain fogs have appeared in ſtrata placed alternately between the hills, and over intervening rivers, valleys, &c. ſo as to admit a ſight of the riſing ſun over thoſe fogs; I have obſerved with admiration the moſt diſtant trees and buſhments, which at other times have appeared ſmall to the naked eye, but while the ſun has been paſſing along a little beneath the horizon obliquely under them, juſt before ſun-riſing, when the ſun has been thus approaching towards trees and buſhments, they have grown apparently very large to the naked eye, and alſo through a teleſcope; and they have loſt that apparent largeneſs as the ſun has been paſſed by them. Thus a few trees ſtanding together on the riſing ground, at the diſtance of a few miles, have appeared to grow up into an apparent mountain. Such apparent mountains formed from trees put on all forms and ſhapes, as ſloping, perpendicular, over-leaning, &c. but ſoon recover their natural appearance when the ſun is paſt by them, or got above the horizon.

" 14. Mountains themſelves, at a diſtance, ſometimes appear larger than at other times. Beaſts and cattle in the midſt of, and being ſurrounded with, water, appear nearer to us than when no water ſurrounds them. Cattle, houſes, trees, all objects on the ſummit of a hill, when ſeen through a fog, and at a proper diſtance, appear enlarged. All bodies admit of larger apparent magnitudes when ſeen through ſome mediums than others.

Harveſt and Horizontal Moon.

" But more particularly,

" 15. I took a cylindrical glaſs-veſſel about two feet high; and having graduated its ſides to inches, I placed it upright on a table, with a piece of paper under the bottom of the glaſs, on which paper were drawn parallel right lines at proper diſtances from each other; and having placed a ſhilling at the bottom of the veſſel, it was nearly as low as the paper. Pouring water into the veſſel, and viewing the ſhilling through the medium of water with one eye, whilſt I beheld with the other eye where the edges of the ſhilling were projected on the paper and its parallels, I found the ſhilling appear larger at every additional inch depth of the water; and this was the caſe if either eye was uſed; and the ſame when the eye was removed far from the ſurface or near to it, or in any proportion thereto.

" 16. I took large veſſels; and, filling them with water, placed different bodies at the bottoms of thoſe veſſels. It always followed, that the greater depth of water I looked through, in a direction from my eye to the objects in the water, the nearer thoſe objects appeared to me. Thus light bodies appeared more mellow and faint, and dark bodies rather better defined, than out of the water, when they were not deeply immerſed. And thus they appeared under whatever directions or poſitions I viewed the bodies.

" 17. I placed different bodies in proper veſſels of fair water, and immerſed my face in the water; viewing the bodies in and through the water. They all appeared to me plain, when not too far from the eye; and altho' a little hazy at the edges, they appeared much enlarged, and always larger through a greater depth of water. Thus a ſhilling appeared nearly as large as half a crown, with a red glowing arch on that ſide oppoſite to the ſun, when the ſun ſhined on the water. From this experiment I concluded, that divers ſee light objects not only larger, but very diſtinctly, in the water."

From theſe experiments he draws a confirmation of his doctrine, that the appearances treated of ariſe from the different ſtrata of the atmoſphere; and then concludes that the rays coming from the ſun are by the horizontal vapours " firſt obſtructed, and many of them totally abſorbed; the reſt proceeding with a retarded motion, are thereby firſt reflected, and then leſs refracted through the humours of the eye; and, laſtly, that hereby the image on the retina becomes enlarged."

Sect. VII. *Of drawing a Meridian Line. Of Solar and Sidereal Time, and of the Equation of Time.*

The foundation of all aſtronomical obſervations is a knowledge of the exact time when the ſun, or any other of the celeſtial bodies, comes to the meridian; and therefore aſtronomers have been very attentive to the moſt proper methods of drawing a meridian line, by which only this can be exactly known. The eaſieſt method of doing this is the following, recommended by Mr Ferguſon, and is found a very good method of placing a ſun-dial horizontally on its pedeſtal.

376 Ferguſon's method of drawing a meridian line.

Make four or five concentric circles (fig. 5.) about a quarter of an inch from one another, on a flat board about a foot in breadth; and let the utmoſt circle be but little

Equation of time, &c.

little leſs than the board will contain. Fix a pin perpendicularly in the centre, and of ſuch a length that its whole ſhadow may fall within the innermoſt circle for at leaſt four hours in the middle of the day. The pin ought to be about an eighth part of an inch thick, and to have a round blunt point. The board being ſet exactly level in the place where the ſun ſhines, ſuppoſe from eight in the morning till four in the afternoon, about which hours the end of the ſhadow ſhould fall without all the circles; watch the times in the forenoon when the extremity of the ſhortening ſhadow juſt touches the ſeveral circles, and there make marks. Then, in the afternoon of the ſame day, watch the lengthening ſhadow; and where its end touches the ſeveral circles in going over them, make marks alſo. Laſtly, with a pair of compaſſes, find exactly the middle point between the two marks on any circle, and draw a ſtraight line from the centre to that point; which line will be covered at noon by the ſhadow of a ſmall upright wire, which ſhould be put in the place of the pin. The reaſon for drawing ſeveral circles is that in caſe one part of the day ſhould prove clear, and the other part ſomewhat cloudy, if you miſs the time when the point of the ſhadow ſhould touch one circle, you may perhaps catch it in touching another. The pin is uſually about five inches in length. The beſt time for drawing a meridian line in this manner is about the ſummer ſolſtice; becauſe the ſun changes his declination ſloweſt, and his altitude faſteſt, in the longeſt days.

If the caſement of a window on which the ſun ſhines at noon be quite upright, you may draw a line along the edge of its ſhadow on the floor, when the ſhadow of the pin is exactly on the meridian line of the board: and as the motion of the ſhadow of the caſement will be much more ſenſible on the floor than that of the ſhadow of the pin on the board, you may know to a few ſeconds when it touches the meridian line on the floor.

377 Another from the Phil. Tranſ

This method may ſuffice for ordinary purpoſes, but for aſtronomers the following is preferable. Take the gnomon of an horizontal dial for the latitude of the place, and to the hypotenuſa fix two ſights, whoſe centres may be parallel to the ſame: let the eye-ſight be a ſmall hole, but the other's diameter muſt be equal to the tangent of the double diſtance of the north-ſtar from the pole; the diſtance of the ſights being made radius, let the ſtile be rivetted to the end of a ſtraight ruler; then when you would make uſe of it, lay the ruler on an horizontal plane, ſo that the end to which the ſtile is fixed may overhang; then look through the eye-ſight, moving the inſtrument till the north-ſtar appears to touch the circumference of the hole in the other ſight, on the ſame hand with the girdle of Caſſiopeia, or on the oppoſite ſide to that whereon the ſtar in the Great Bear's rump is at that time; then draw a line by the edge of the ruler, and it will be a true meridian line.

378 To find the exact time of noon.

A meridian line being by either of theſe methods exactly drawn, the time when the ſun or any other of the celeſtial bodies is exactly in the meridian may be found by a common quadrant, placing the edge of it along the line, and obſerving when the ſun or other luminary can be ſeen exactly through its two ſights, and noting exactly the time; which, ſuppoſing the luminary viewed to be the ſun, will be exactly noon, or 12 o'clock; but as the apparent diameter of the ſun is pretty large, it ought to be known exactly when his centre is in the meridian, which will be ſome ſhort ſpace after his weſtern limb has arrived at it, and before his eaſtern limb come thither. It will be proper, therefore, to obſerve exactly the time of the two limbs being ſeen through the ſights of the quadrant; and the half of the difference between theſe times added to the one or ſubtracted from the other, will give the exact time when the ſun's centre is in the meridian. What we ſay with regard to the ſun, is alſo applicable to the moon; but not to the ſtars, which have no ſenſible diameter. To render this more intelligible, the following ſhort deſcription of the quadrant, and method of taking the altitudes of celeſtial bodies by it, is ſubjoined.

Equation of Time, &c.

379 To take the altitudes of the celeſtial bodies.

Let HOX (fig. 195.) be a horizontal line, ſuppoſed to be extended from the eye at A to X, where the ſky and earth ſeem to meet at the end of a long and level plain: and let S be the ſun. The arc XY will be the ſun's height above the horizon at X, and is found by the inſtrument EDC, which is a quadrantal board, or plate of metal, divided into 90 equal parts or degrees on its limb DPC; and has a couple of little braſs plates, as *a* and *b*, with a ſmall hole in each of them, called *ſight-holes*, for looking through, parallel to the edge of the quadrant whereon they ſtand. To the centre E is fixed one end of a thread F, called the *plumb-line*, which has a ſmall weight or plummet P fixed to its other end. Now, if an obſerver holds the quadrant upright, without inclining it to either ſide, and ſo that the horizon at X is ſeen through the ſight-holes *a* and *b*, the plumb-line will cut or hang over the beginning of the degrees at o, in the edge EC; but if he elevates the quadrant ſo as to look through the ſight-holes at any part of the heavens, ſuppoſe to the ſun at S; juſt ſo many degrees as he elevates the ſight-hole *b* above the horizontal line HOX, ſo many degrees will the plumb-line cut in the limb CP of the quadrant. For, let the obſerver's eye at A be in the centre of the celeſtial arc XYV (and he may be ſaid to be in the centre of the ſun's apparent and diurnal orbit, let him be on what part of the earth he will), in which arc the ſun is at that time, ſuppoſe 25 degrees high, and let the obſerver hold the quadrant ſo that he may ſee the ſun through the ſight-holes; the plumb-line freely playing on the quadrant will cut the 25th degree in the limb CP, equal to the number of degrees of the ſun's altitude at the time of obſervation. (N. B. Whoever looks at the ſun, muſt have a ſmoked glaſs before his eyes, to ſave them from hurt. The better way is, not to look at the ſun through the ſight-holes, but to hold the quadrant facing the eye, at a little diſtance, and ſo that, the ſun ſhining through one hole, the ray may be ſeen to fall on the other.)

380 Difference between ſolar and ſidereal days.

By obſervation made in the manner above directed, it is found, that the ſtars appear to go round the earth in 23 hours 56 minutes 5 ſeconds, and the ſun in 24 hours: ſo that the ſtars gain three minutes 56 ſeconds upon the ſun every day, which amounts to one diurnal revolution in a year; and therefore, in 365 days as meaſured by the returns of the ſun to the meridian, there are 366 days as meaſured by the ſtars returning to it: the former are called *ſolar days*, and the latter *ſidereal*.

If the earth had only a diurnal motion, without an annual, any given meridian would revolve from the ſun to the ſun again in the ſame quantity of time as from any ſtar to the ſame ſtar again; becauſe the ſun would never change his place with reſpect to the ſtars. But,

Equation of Time, &c.

as the earth advances almoſt a degree eaſtward in its orbit in the time that it turns eaſtward round its axis, whatever ſtar paſſes over the meridian on any day with the ſun, will paſs over the ſame meridian on the next day when the ſun is almoſt a degree ſhort of it; that is, 3 minutes 56 ſeconds ſooner. If the year contained only 360 days, as the ecliptic does 360 degrees, the ſun's apparent place, ſo far as his motion is equable, would change a degree every day; and then the ſidereal days would be juſt 4 minutes ſhorter than the ſolar.

Let ABCDEFGHIKLM (fig. 179.) be the earth's orbit, in which it goes round the ſun every year, according to the order of the letters, that is, from weſt to eaſt; and turns round its axis in the ſame way from the ſun to the ſun again in every 24 hours. Let S be the ſun, and R a fixed ſtar at ſuch an immenſe diſtance, that the diameter of the earth's orbit bears no ſenſible proportion to that diſtance. Let N*m* be any particular meridian of the earth, and N a given point or place upon that meridian when the earth is at A, the ſun S hides the ſtar R, which would always be hid if the earth never removed from A; and conſequently, as the earth turns round its axis, the point N would always come round to the ſun and ſtar at the ſame time. But when the earth has advanced, ſuppoſe a twelfth part of its orbit, from A to B, its motion round its axis will bring the point N a twelfth part of a natural day, or two hours, ſooner to the ſtar than to the ſun; for the angle of NB*n* is equal to the angle ASB: and therefore any ſtar, which comes to the meridian at noon with the ſun when the earth is at A, will come to the meridian at 10 in the forenoon when the earth is at B. When the earth comes to C, the point N will have the ſtar on its meridian at 8 in the morning, or four hours ſooner than it comes round to the ſun: for it muſt revolve from N to *n*, before it has the ſun in its meridian. When the earth comes to D, the point N will have the ſtar on its meridian at 6 in the morning; but that point muſt revolve ſix hours more from N to *n*, before it has mid-day by the ſun; for now the angle ASD is a right angle, and ſo is ND*n*; that is, the earth has advanced 90 degrees in its orbit, and muſt turn 90 degrees on its axis to carry the point N from the ſtar to the ſun: for the ſtar always comes to the meridian when N*m* is parallel to RSA; becauſe DS is but a point in reſpect of RS. When the earth is at E, the ſtar comes to the meridian at 4 in the morning; at F, at two in the morning; and at G, the earth having gone half round its orbit, N points to the ſtar R at midnight, it being then directly oppoſite to the ſun; and therefore, by the earth's diurnal motion, the ſtar comes to the meridian 12 hours before the ſun. When the earth is at H, the ſtar comes to the meridian at 10 in the evening; at I, it comes to the meridian at 8, that is, 16 hours before the ſun; at K, 18 hours before him; at L, 20 hours; at M, 22; and at A, equally with the ſun again.

381 Sidereal year contains 366 days.

Thus it is plain, than an abſolute turn of the earth on its axis (which is always completed when any particular meridian comes to be parallel to its ſituation at any time of the day before) never brings the ſame meridian round from the ſun to the ſun again; but that the earth requires as much more than one turn on its axis to finiſh a natural day, as it has gone forward in that time; which, at a mean ſtate, is a 365th part of a circle. Hence, in 365 days, the earth turns 366 times round its axis; and therefore, as a turn of the earth on its axis completes a ſidereal day, there muſt be one ſidereal day more in a year than the number of ſolar days, be the number what it will, on the earth or any other planet. One turn being loſt with reſpect to the number of ſolar days in a year, by the planet's going round the ſun; juſt as it would be loſt to a traveller, who, in going round the earth, would loſe one day by following the apparent diurnal motion of the ſun; and conſequently would reckon one day leſs at his return (let him take what time he would to go round the earth) than thoſe who remained all the while at the place from which he ſet out. So if there were two earths revolving equally on their axes, and if one remained at A until the other had gone round the ſun from A to A again, that earth which kept its place at A would have its ſolar and ſidereal days always of the ſame length; and ſo would have one ſolar day more than the other at its return. Hence, if the earth turned but once round its axis in a year, and if that turn was made the ſame way as the earth goes round the ſun, there would be continual day on one ſide of the earth, and continual night on the other.

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382 Inequality of ſolar time.

The earth's motion on its axis being perfectly uniform, and equal at all times of the year, the ſidereal days are always preciſely of an equal length; and ſo would the ſolar or natural days be, if the earth's orbit were a perfect circle, and its axis perpendicular to its orbit. But the earth's diurnal motion on an inclined axis, and its annual motion in an elliptic orbit, cauſe the ſun's apparent motion in the heavens to be unequal: for ſometimes he revolves from the meridian to the meridian again in ſomewhat leſs than 24 hours, ſhown by a well-regulated clock; and at other times in ſomewhat more: ſo that the time ſhown by an equal going clock and a true ſun-dial is never the ſame but on the 15th of April, the 16th of June, the 31ſt of Auguſt, and the 24th of December. The clock, if it goes equably and true all the year round, will be before the ſun from the 24th of December till the 15th of April; from that time till the 16th of June, the ſun will be before the clock; from the 16th of June till the 31ſt of Auguſt, the clock will be again before the ſun; and from thence to the 24th of December, the ſun will be faſter than the clock.

393 Equation of time explained.

As the equation of time, or difference between the time ſhown by a well-regulated clock and a true ſun-dial, depends upon two cauſes, namely, the obliquity of the ecliptic, and the unequal motion of the earth in it, we ſhall firſt explain the effects of theſe cauſes ſeparately conſidered, and then the united effects reſulting from their combination.

The earth's motion on its axis being perfectly equable, or always at the ſame rate, and the plane of the equator being perpendicular to its axis, it is evident that in equal times equal portions of the equator paſs over the meridian; and ſo would equal portions of the ecliptic, if it were parallel to, or coincident with, the equator. But, as the ecliptic is oblique to the equator, the equable motion of the earth carries unequal portions of the ecliptic over the meridian in equal times, the difference being proportionate to the obliquity; and as ſome parts of the ecliptic are much more

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more oblique than others, thoſe differences are unequal among themſelves. Therefore, if two ſuns ſhould ſtart from the beginning either of Aries or Libra, and continue to move through equal arcs in equal times, one in the equator and the other in the ecliptic, the equatorial ſun would always return to the meridian in 24 hours time, as meaſured by a well regulated clock: but the ſun in the ecliptic would return to the meridian ſometimes ſooner and ſometimes later than the equatorial ſun; and only at the ſame moments with him on four days of the year; namely, the 20th of March, when the ſun enters Aries; the 21ſt of June, when he enters Cancer; the 23d of September, when he enters Libra; and the 21ſt of December, when he enters Capricorn; and to this fictitious ſun the motion of a well-regulated clock always anſwers.

Fig. 180.

Let Z ♈ ꝛ ♎ be the earth; ZFRꝛ, its axis; *abcde*, &c. the equator; ABCDE, &c. the northern half of the ecliptic from ♈ to ♎ on the ſide of the globe next the eye; and MNOP, &c. the ſouthern half on the oppoſite ſide from ♎ to ♈. Let the points at A, B, C, D, E, F, &c quite round from ♈ to ♈ again bound equal portions of the ecliptic, gone through in equal times by the real ſun; and thoſe at *a*, *b*, *c*, *d*, *e*, *f*, &c. equal portions of the equator deſcribed in equal times by the fictitious ſun; and let Z ♈ ꝛ be the meridian.

As the real ſun moves obliquely in the ecliptic, and the fictitious ſun directly in the equator, with reſpect to the meridian; a degree, or any number of degrees, between ♈ and F on the ecliptic, muſt be nearer the meridian Z ♈ ꝛ, than a degree, or any correſponding number of degrees, on the equator from ♈ to *f*; and the more ſo, as they are the more oblique: and therefore the true ſun comes ſooner to the meridian every day whilſt he is in the quadrant ♈ F, than the fictitious ſun does in the quadrant ♈ *f*; for which reaſon, the ſolar noon precedes noon by the clock, until the real ſun comes to F, and the fictitious to *f*; which two points, being equidiſtant from the meridian, both ſuns will come to it preciſely at noon by the clock.

Whilſt the real ſun deſcribes the ſecond quadrant of the ecliptic FGHIKL from Cancer to ♎, he comes later to the meridian every day than the fictitious ſun moving through the ſecond quadrant of the equator from *f* to ♎; for the points at G, H, I, K, and L, being farther from the meridian, their correſponding points at *g*, *h*, *i*, and *l*, muſt be later of coming to it: and as both ſuns come at the ſame moment to the point ♎, they come to the meridian at the moment of noon by the clock.

In departing from Libra, through the third quadrant, the real ſun going through MNOPQ towards ♑ at R, and the fictitious ſun through *mnopq* towards *r*, the former comes to the meridian every day ſooner than the latter, until the real ſun comes to ♑, and the fictitious to *r* and then they come both to the meridian at the ſame time.

Laſtly, as the real ſun moves equably thro' STUVW, from ♑ towards ♈; and the fictitious ſun thro' *stuvw*, from *r* towards ♈, the former comes later every day to the meridian than the latter, until they both arrive at the point ♈, and then they make it noon at the ſame time with the clock.

Having explained one cauſe of the difference of time ſhown by a well-regulated clock and a true ſun-dial, and conſidered the ſun, not the earth, as moving in the ecliptic; we now proceed to explain the other cauſe of this difference, namely, the inequality of the ſun's apparent motion, which is ſhowed in ſummer, when the ſun is fartheſt from the earth, and ſwifteſt in winter when he is neareſt to it. But the earth's motion on its axis is equable all the year round, and is performed from weſt to eaſt; which is the way that the ſun appears to change his place in the ecliptic.

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If the ſun's motion were equable in the ecliptic, the whole difference between the equal time as ſhown by the clock, and the unequal time as ſhown by the ſun, would ariſe from the obliquity of the ecliptic. But the ſun's motion ſometimes exceeds a degree in 24 hours, though generally it is leſs: and when his motion is ſloweſt, any particular meridian will revolve ſooner to him than when his motion is quickeſt; for it will overtake him in leſs time when he advances a leſs ſpace than when he moves through a larger.

Now, if there were two ſuns moving in the plane of the ecliptic, ſo as to go round it in a year; the one deſcribing an equal arc every 24 hours, and the other deſcribing ſometimes a leſs arc in 24 hours, and at other times a larger, gaining at one time of the year what is loſt at the oppoſite; it is evident, that either of theſe ſuns would come ſooner or later to the meridian than the other, as it happened to be behind or before the other; and when they were both in conjunction, they would come to the meridian at the ſame moment.

As the real ſun moves unequably in the ecliptic, let us ſuppoſe a fictitious ſun to move equably in a circle coincident with the plane of the ecliptic Let ABCD (fig. 181.) be the ecliptic or orbit in which the real ſun moves, and the dotted circle *abcd* the imaginary orbit of the fictitious ſun: each going round in a year according to the order of letters, or from weſt to eaſt. Let HIKL be the earth turning round its axis the ſame way every 24 hours; and ſuppoſe both ſuns to ſtart from A and *a*, in a right line with the plane of the meridian EH, at the ſame moment: the real ſun at A, being then at his greateſt diſtance from the earth, at which time his motion is ſloweſt; and the fictitious ſun at *a*, whoſe motion is always equable, becauſe his diſtance from the earth is ſuppoſed to be always the ſame. In the time that the meridian revolves from H to H again, according to the order of the letters HIKL, the real ſun has moved from A to F; and the fictitious with a quicker motion from *a* to *f*, through a large arc: therefore the meridian EH will revolve ſooner from H to *h* under the real ſun at F, than from H E to *k* under the fictitious ſun at *f*; and conſequently it will then be noon by the ſun-dial ſooner than by the clock.

As the real ſun moves from A towards C, the ſwiftneſs of his motion increaſes all the way to C, where it is at the quickeſt But notwithſtanding this, the fictitious ſun gains ſo much upon the real, ſoon after his departing from A, that the increaſing velocity of the real ſun does not bring him up with the equally moving fictitious ſun till the former comes to C, and the latter to *c*, when each has gone half round its reſpective orbit; and then being in conjunction, the meridian EH, revolving to EK, comes to both ſuns at the ſame time,

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and therefore it is noon by them both at the same moment.

But the increased velocity of the real sun, now being at the quickest, carries him before the fictitious one; and therefore, the same meridian will come to the fictitious sun sooner than to the real: for whilst the fictitious sun moves from *c* to *g*, the real sun moves through a greater arc from C to G: consequently the point K has its noon by the clock when it comes to *k*, but not its noon by the sun till it comes to *l*. And although the velocity of the real sun diminishes all the way from C to A, and the fictitious sun by an equable motion is still coming nearer to the real sun, yet they are not in conjunction till the one comes to A and the other to *a*, and then it is noon by them both at the same moment.

Thus it appears, that the solar noon is always later than noon by the clock whilst the sun goes from C to A; sooner, whilst he goes from A to C; and at these two points the sun and clock being equal, it is noon by them both at the same moment.

The point A is called the sun's *apogee*, because when he is there he is at his greatest distance from the earth; the point C his *perigee*, because when in it he is at his least distance from the earth: and a right line, as AEC, drawn through the earth's centre, from one of the points to the other, is called the *line of the Apsides*.

The distance that the sun has gone in any time from his apogee (not the distance he has to go to it, though ever so little) is called his *mean anomaly*, and is reckoned in signs and degrees, allowing 30 degrees to a sign. Thus, when the sun has gone suppose 174 degrees from his apogee at A, he is said to be 5 signs 14 degrees from it, which is his mean anomaly; and when he is gone suppose 355 degrees from his apogee, he is said to be 11 signs 25 degrees from it, although he be but 5 degrees short of A in coming round to it again.

From what was said above, it appears, that when the sun's anomaly is less than 6 signs, that is, when he is any where between A and C, in the half ABC of his orbit, the solar noon precedes the clock noon; but when his anomaly is more than 6 signs, that is, when he is any where between C and A, in the half CDA of his orbit, the clock noon precedes the solar. When his anomaly is 0 signs 0 degrees, that is, when he is in his apogee at A; or 6 signs 0 degrees, which is when he is in his perigee at C; he comes to the meridian at the moment that the fictitious sun does, and then it is noon by them both at the same instant.

Sect. VIII. *Of calculating the Distances, Magnitudes, &c. of the Sun, Moon, and Planets.*

384
To find the moon's horizontal parallax.

This is accomplished by finding out the horizontal parallax of the body whose distance you desire to know; that is, the angle under which the semidiameter of the earth would appear provided we could see it from that body; and this is to be found out in the following manner.

Let BAG (fig. 171.) be one half of the earth, AC its semidiameter, S the sun, *m* the moon, and EKOL a quarter of the circle described by the moon in revolving from the meridian to the meridian again. Let CRS be the rational horizon of an observer at A, extended to the sun in the heavens; and HAO, his sensible horizon extended to the moon's orbit. ALC is the angle under which the earth's semidiameter AC is seen from the moon at L; which is equal to the angle OAL, because the right lines AO and CL which include both these angles are parallel. ASC is the angle under which the earth's semidiameter AC is seen from the sun at S: and is equal to the angle OA*f*, because the lines AO and CRS are parallel. Now, it is found by observation, that the angle OAL is much greater than the angle OA*f*; but OAL is equal to ALC, and OA*f* is equal to ASC. Now as ASC is much less than ALC, it proves that the earth's semidiameter AC appears much greater as seen from the moon at L than from the sun at S; and therefore the earth is much farther from the sun than from the moon. The quantities of these angles may be determined by observation in the following manner.

Let a graduated instrument, as DAE (the larger the better), having a moveable index with sight-holes, be fixed in such a manner, that its plane surface may be parallel to the plane of the equator, and its edge AD in the meridian: so that when the moon is in the equinoctial, and on the meridian ADE, she may be seen through the sight-holes when the edge of the moveable index cuts the beginning of the divisions at 0, on the graduated limb DE; and when she is so seen, let the precise time be noted. Now as the moon revolves about the earth from the meridian to the meridian again in about 24 hours 48 minutes, she will go a fourth part round it in a fourth part of that time, viz. in 6 hours 12 minutes, as seen from C, that is, from the earth's centre or pole. But as seen from A, the observer's place on the earth's surface, the moon will seem to have gone a quarter round the earth when she comes to the sensible horizon at O; for the index through the sights of which she is then viewed will be at *d*, 90 degrees from D, where it was when she was seen at E. Now let the exact moment when the moon is seen at O (which will be when she is in or near the sensible horizon) be carefully noted (c), that it may be known in what time she has gone from E to O; which time subtracted from six hours 12 minutes (the time of her going from E to L) leaves the time of her going from O to L, and affords an easy method for finding the angle OAL (called *the moon's horizontal parallax*, which is equal to the angle ALC) by the following analogy: As the time of the moon's describing the arc EO is to 90 degrees, so is 6 hours 12 minutes to the degrees of the arc D *d* E, which measures the angle EAL; from which subtract 90 degrees, and there remains the angle OAL, equal to the angle ALC, under which the earth's semidiameter AC is seen from the the moon. Now, since all the angles of a right-lined triangle are equal to 180 degrees, or to two right angles,

(c) Here proper allowance must be made for the refraction, which being about 34 minutes of a degree in the horizon, will cause the moon's centre to appear 34 minutes above the horizon when her centre is really in it.

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angles, and the sides of a triangle are always proportional to the sines of the opposite angles, say, by the Rule of Three, as the sine of the angle ALC at the moon L, is to its opposite side AC, the earth's semidiameter, which is known to be 3985 miles; so is radius, viz. the sine of 90 degrees, or of the right angle ACL to its opposite side AL, which is the moon's distance at L from the observer's place at A on the earth's surface; or, so is the sine of the angle CAL to its opposite side CL, which is the moon's distance from the earth's centre, and comes out at a mean rate to be 240,000 miles. The angle CAL is equal to what OAL wants of 90 degrees.

385 Another method.

Other methods have been fallen upon for determining the moon's parallax; of which the following is recommended as the best, by Mr Ferguson, though hitherto it has not been put in practice. Let two observers be placed under the same meridian, one in the northern hemisphere and the other in the southern, at such a distance from each other, that the arc of the celestial meridian included between their two zenith's may be at least 80 or 90 degrees. Let each observer take the distance of the moon's centre from his zenith, by means of an exceeding good instrument, at the moment of her passing the meridian: and these two zenith distances of the moon together, and their excess above the distance between the two zeniths, will be the distance between the two apparent places of the moon. Then, as the sum of the natural sines of the two zenith-distances of the moon is to radius, so is the distance between her two apparent places to her horizontal parallax: which being found, her distance from the earth's centre may be found by the analogy mentioned above.

Thus, in fig. 199. let VECQ be the earth, M the moon, and *Zbaz* an arc of the celestial meridian. Let V be Vienna, whose latitude EV is 48° 20′ north; and C the Cape of Good Hope, whose latitude EC is 34° 30′ south: both which latitudes we suppose to be accurately determined beforehand by the observers. As these two places are on the same meridian *n*VEC*s*, and in different hemispheres, the sum of their latitudes 82° 50′ is their distance from each other. Z is the zenith of Vienna, and z the zenith of the Cape of Good Hope; which two zeniths are also 82° 50′ distant from each other, in the common celestial meridian Z*z*. To the observer at Vienna, the moon's centre will appear at *a* in the celestial meridian; and at the same instant, to the observer at the Cape, it will appear at *b*. Now suppose the moon's distance Z *a* from the zenith of Vienna to be 38° 1′ 53″, and her distance *z b* from the zenith of the Cape of Good Hope to be 46° 4′ 41″: the sum of these two zenith distances (*Za*+*zb*) is 84° 6′ 34″; from which subtract 82° 50″, the distance of Z*z* between the zeniths of these two places, and there will remain 1° 16′ 34″ for the arc *ba*, or distance between the two apparent places of the moon's centre, as seen from V and from C. Then, supposing the tabular radius to be 10,000,000, the natural sine of 38° 1. 53″ (the arc *Za*) is 6,160,816, and the natural sine of 46′ 4′ 41″ the arc *zb*) is 7,202,821: the sum of both these sines is 13,363,637. Say therefore, As 13,363,637 is to 10,000,000, so is 1° 16′ 34″ to 57′ 18″, which is the moon's horizontal parallax.

If the two places of observation be not exactly under the same meridian, their difference of longitude must be accurately taken, that proper allowance may be made for the moon's declination whilst she is passing from the meridian of the one to the meridian of the other.

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The parallax, and consequently the distance and bulk, of any primary planet, might be found in the above manner, if the planet was near enough to the earth, so as to make the difference of its two apparent places sufficiently sensible: but the nearest planet is too remote for the accuracy required.

386 Parallax of the sun difficult to be found.

The sun's distance from the earth might be found the same way, though with more difficulty, if his horizontal parallax, or the angle OAS equal to the angle ASC (fig. 171.), were not small so as to be hardly perceptible, being found in this way to be scarce 10 seconds of a minute, or the 360th part of a degree. Hence all astronomers, both ancient and modern have failed in taking the sun's parallax to a sufficient degree of exactness; but as some of the methods used are very ingenious, and show the great acuteness and sagacity of the ancient astronomers, we shall here give an account of them.

387 Hipparchus's method of finding it.

The first method was invented by Hipparchus; and has been made use of by Ptolemy and his followers, and many other astronomers. It depends on an observation of an eclipse of the moon: And the principles on which it is founded, are, 1*st*, In a lunar eclipse, the horizontal parallax of the sun is equal to the difference between the apparent semidiameter of the sun, and half the angle of the conical shadow; which is easily made out in this manner. Let the circle AFG (fig. 87.) represent the sun, and DHC the earth; let DHM be the shadow, and DMC the half angle of the cone. Draw from the centre of the sun the right line SD touching the earth, and the angle DS is the apparent semidiameter of the earth, seen from the sun, which is equal to the horizontal parallax of the sun; and the angle ADS is the apparent semidiameter of the sun seen from the earth: The external angle ADS is equal to the two internals DMS and DSM, by the 32d Prop. Elem. I. And therefore the angle DSM, or DSC, is equal to the difference of the angles ADS and DMS. 2*dly*, Half the angle of the cone is equal to the difference of the horizontal parallax of the moon and the apparent semidiameter of the shadow, seen from the earth at the distance of the moon. For let CTE be the earth, CME the shadow, which at the distance of the moon being cut by a plane, the section will be the circle FLK, whose semidiameter is FG, and is seen from the centre of the earth under the angle FTG. But by the 32d Prop. Elem. I. the angle CFT is equal to the two internals FMT and FTM. Wherefore the angle FMT is the difference of the two angles CFT and GTF: But the angle CFT is the angle under which the semidiameter of the earth is seen from the moon, and this is equal to the horizontal parallax of the moon; and the angle GTF is the apparent semidiameter of the shadow seen from the earth's centre. It is therefore evident that the half angle of the cone is equal to the difference of the horizontal parallax of the moon, and the apparent semidiameter of the shadow seen from the earth. Wherefore, if to the apparent semidiameter of the sun there be added the apparent semidiameter of the shadow, from the sum you take away the horizontal parallax of the moon, there

Fig. 89.

Fig. 173.

will

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will remain the horizontal parallax of the ſun; which therefore, if theſe were accurately known, would be likewiſe known accurately: But none of them can be ſo exactly and nicely obtained, as to be ſufficient for determining the parallax of the ſun; for very ſmall errors, which cannot be eaſily avoided in meaſuring theſe angles will produce very great errors in the parallax; and there will be a prodigious difference in the diſtances of the ſun when drawn from theſe parallaxes. For example, Suppoſe the horizontal parallax of the moon to be 60′ 15″, the ſemidiameter of the ſun 16′, and the ſemidiameter of the ſhadow 44′ 30″, we ſhall conclude from thence, that the parallax of the ſun was 15″, and his diſtance from the earth about 13,700 ſemidiameters of the earth. But if there be an error committed in determining the ſemidiameter of the ſhadow, of 12″ in defect (and certainly the ſemidiameter of the ſhadow cannot be had ſo preciſely as not to be liable to ſuch an error), that is, if inſtead of 44′ 30″ we put 44′ 18″ for the apparent diameter of the ſhadow, all the others remaining as before, we ſhall have the parallax of the ſun 3″, and its diſtance from the earth almoſt 70,000 ſemidiameters of the earth, which is five times more than what it was by the firſt poſition. But if the fault were in exceſs, or the diameter of the ſhadow exceeded the true by 12″, ſo that we ſhould put in 44′ 42″, the parallax would ariſe to 27″, and the diſtance of the ſun only 7700 of the earth's ſemidiameters; which is nine times leſs than what it comes to by a like error in defect. If an error in defect was committed of 15″, which is ſtill but a ſmall miſtake, the ſun's parallax would be equal to nothing, and his diſtance infinite. Wherefore, ſince from ſo ſmall miſtakes the parallax and diſtance of the ſun vary ſo much, it is plain that the diſtance of the ſun cannot be obtained by this method.

388 This method inſufficient.

389 Ariſtarchus's method.

Since therefore, the angle that the earth's ſemidiameter ſubtends at the ſun is ſo ſmall that it cannot be determined by any obſervation, Ariſtarchus Samius, an ancient and great philoſopher and aſtronomer, contrived a very ingenious way for finding the angle which the ſemidiameter of the moon's orbit ſubtends when ſeen from the ſun: This angle is about 60 times bigger than the former, ſubtended only to the earth's ſemidiameter. To find this angle, he lays down the following principles.

From the phaſes of the moon, it hath been demonſtrated, that if a plane paſſed through the moon's centre, to which the line joining the ſun and moon's centre was perpendicular, this plane would divide the illuminated hemiſphere of the moon from the dark one: And therefore, if this plane ſhould likewiſe paſs through the eye of a ſpectator on the earth, the moon would appear biſected, or like half a circle; and a right line, drawn from the earth to the centre of the moon, would be in the plane of illumination, and conſequently would be perpendicular to the right line which joins the centres of the ſun and moon. Let S be be the ſun, and T the earth, AL*q* a quadrant of the moon's orbit; and let the line SL, drawn from the ſun, touch the orbit of the moon in L; the angle TLS will be a right angle: And therefore, when the moon is ſeen in L, it will appear biſected, or juſt half a circle. At the ſame time take the angle LTS, the elongation of the moon from the ſun, and then we ſhall have the angle LST, its complement to a right angle. But we have the ſide TL, by which we can find the ſide ST, the diſtance of the ſun from the earth.

Fig. 90.

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But the difficult point is to determine exactly the moment of time when the moon is biſected, or in its true dichotomy; for there is a conſiderable ſpace of time both before and after the dichotomy, nay even in the quadrature, when the moon will appear biſected, or half a circle; ſo that the exact moment of biſection cannot be known by obſervation, as experience tells us: And conſequently, the true diſtance of the ſun from the earth cannot be obtained by this method.

390 This method inſufficient.

Since the moment in which the true dichotomy happens is uncertain, but it is certain that it happens before the quadrature; Ricciolus takes that point of time which is in the middle, between the time that the phaſis begins to be doubtful whether it be biſected or not, and the time of quadrature: but he had done better, if he had taken the middle point between the time when it becomes doubtful whether the moon's ſide is concave or ſtraight, and the time again when it is doubtful whether it is ſtraight or convex; which point of time is after the quadrature: and if he had done this, he would have found the ſun's diſtance a great deal more than he has made it.

391 Ricciolus's method.

There is no need to confine this method to the phaſis of a dichotomy, or biſection, for it can be as well performed when the moon has any other phaſis bigger or leſs than a dichotomy: for obſerve by a very good teleſcope, with a micrometer, the phaſis of the moon, that is, the proportion of the illuminated part of the diameter to the whole; and at the ſame moment of time take her elongation from the ſun: The illuminated part of the diameter, if it be leſs than the ſemidiameter, is to be ſubducted from the ſemidiameter; but if it be greater, the ſemidiameter is to be ſubducted from it, and mark the reſidue: then ſay, As the ſemidiameter of the moon is to the reſidue, ſo is the radius to the ſine of an angle, which is therefore found: this angle added to, or ſubtracted from, a right angle, gives the exterior angle of the triangle at the moon: but we have the angle at the earth, which is the elongation obſerved; which therefore being ſubducted from the exterior angle, leaves the angle at the ſun. And in the triangle SLT, having all the angles and one ſide LT, we can find the other ſide ST, the diſtance of the ſun from the earth. But it is almoſt impoſſible to determine accurately the quantity of the lunar phaſis, ſo that there may not be an error of a few ſeconds committed; and conſequently, we cannot by this method find preciſely enough the true diſtance of the ſun. However, from ſuch obſervations, we are ſure, that the ſun is above 7000 ſemidiameters of the earth diſtant from us. Since therefore the true diſtance of the ſun can neither be found by eclipſes nor by the phaſes of the moon, the aſtronomers are forced to have recourſe to the parallaxes of the planets that are next to us, as Mars and Venus, which are ſometimes much nearer to us than the ſun is. Their parallaxes they endeavour to find by ſome of the methods above explained; and if theſe parallaxes were known, then the parallax and diſtance of the ſun, which cannot directly by any obſervations be attained, would eaſily be deduced from them. For from the theory of the motions of the earth and planets, we know at any time the proportion of

392 Another by Dr Keil.

393 All theſe methods inſufficient.

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of the distances of the sun and planets from us; and the horizontal parallaxes are in a reciprocal proportion to these distances. Wherefore, knowing the parallax of a planet we may from thence find the parallax of the sun.

394 Another method from the parallax of Mars.

Mars, when he is in an achronycal position, that is opposite to the sun, is twice as near to us as the sun is; and therefore his parallax will be twice as great. But Venus, when she is in her inferior conjunction with the sun, is four times nearer to us than he is, and her parallax is greater in the same proportion: Therefore, though the extreme smallness of the sun's parallax renders it unobservable by our senses, yet the parallaxes of Mars or Venus, which are twice or four times greater, may become sensible. The astronomers have bestowed much pains in finding out the parallax of Mars; but some time ago Mars was in his opposition to the sun, and also in his perihelion; and consequently in his nearest approach to the earth: And then he was most accurately observed by two of the most eminent astronomers of our age, who have determined his parallax to have been scarce 30 seconds; from whence it was inferred, that the parallax of the sun is scarce 11 seconds, and his distance about 19,000 semidiameters of the earth.

395 From that of Venus.

As the parallax of Venus is still greater than that of Mars, Dr Halley proposed a method by it of finding the distance of the sun to within a 500th part of the whole. The times of observation were at her transits over the sun in 1761 and 1769. At these times the greatest attention was given by astronomers, but it was found impossible to observe the exact times of immersion and emersion with such accuracy as had been expected; so that the matter is not yet determined so exactly as could be wished. The method of calculating the sun's distance by means of these transits is as follows.

In fig. 91. let DBA be the earth, V Venus, and TSR the eastern limb of the sun. To an observer at B, the point *t* of that limb will be on the meridian, its place referred to the heaven will be at E, and Venus will appear just within it at S. But at the same instant, to an observer at A, Venus is east of the sun, in the right line AVF; the point *t* of the sun's limb appears at *e* in the heaven; and if Venus were then visible she would appear at F. The angle CVA is the horizontal parallax of Venus, which we seek; and is equal to the opposite angle FVE, whose measure is the arc FE. ASC is the sun's horizontal parallax, equal to the opposite angle *e* SE, whose measure is the arc *e* E; and FA*e* (the same as VA*v*) is Venus's horizontal parallax from the sun, which may be found by observing how much later in absolute time her total ingress on the sun is, as seen from A than as seen from B, which is the time she takes to move from V to *v* in her orbit OV*v*.

Fig. 6.

It appears by the tables of Venus's motion and the sun's, that at the time of her transit in 1761 she moved 4′ of a degree on the sun's disk in 60 minutes of time: and consequently 4″ of a degree in one minute of time.

Now, let us suppose that A is 90° west of B, so that when it is noon at B it will be six in the morning at A; that the total ingress as seen from B is at one minute past 12, but that as seen from A it is at seven minutes 30 seconds past six; deduct six hours for the difference of meridians of A and B, and the remainder will be six minutes 30 seconds for the time by which the total ingress of Venus on the sun at S, is later as seen from A than as seen from B; which time being converted into parts of a degree is 26″, or the arc F*e* of Venus's horizontal parallax from the sun; for, as 1 minute of time is to 4 seconds of a degree, so is 6½ minutes of time to 26 seconds of a degree.

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The times in which the planets perform their annual revolutions about the sun are already known by observation.—From these times, and the universal power of gravity by which the planets are retained in their orbits, it is demonstrable, that if the earth's mean distance from the sun be divided into 100,000 equal parts, Mercury's mean distance from the sun must be equal to 38,710 of these parts—Venus's mean distance from the sun to 72,333——Mars's mean distance, 152,369—Jupiter's, 520,096—and Saturn's 954,006. Therefore when the number of miles contained in the mean distance of any planet from the sun is known, we can by these proportions find the mean distance in miles of all the rest.

At the time of the abovementioned transit, the earth's distance from the sun was 1015 (the mean distance being here considered as 1000), and Venus's distance from the sun 726 (the mean distance being considered as 723), which differences from the mean distances arise from the elliptical figure of the planets orbits—Subtracting 726 parts from 1015, there remain 289 parts for Venus's distance from the earth at that time.

Now, since the horizontal parallaxes of the planets are inversely as their distances from the earth's centre, it is plain, that as Venus was between the earth and the sun on the day of her transit, and consequently her parallax at that time greater than the sun's, if her horizontal parallax was then ascertained by observation, the sun's horizontal parallax might be found, and consequently his distance from the earth.—Thus, suppose Venus's horizontal parallax was found to be 36″.3480, then, As the sun's distance 1015 is to Venus's distance 289, so is Venus's horizontal parallax 36″.3480 to the sun's horizontal parallax 10″.3493 on the day of her transit. And the difference of these two parallaxes, viz. 25″.9987 (which may be esteemed 26″), will be the quantity of Venus's horizontal parallax from the sun.

To find the sun's horizontal parallax at the time of his mean distance from the earth, say, As 1000 parts of the sun's mean distance from the earth's centre, is to 1015, his distance therefrom on the day the transit, so is 10″.3493, his horizontal parallax on that day, to 10″.5045, his horizontal parallax at the time of his mean distance from the earth's centre.

396 Method of computing the sun's distance from his parallax.

The sun's parallax being thus (or any other way supposed to be) found, at the time of his mean distance from the earth, we may find his true distance therefrom, in semidiameters of the earth, by the following analogy. As the sine (or tangent of so small an arc as that) of the sun's parallax 10″.5045 is to radius, so is unity or the earth's semidiameter to the number of semidiameters of the earth that the sun is distant from its centre; which number, being multiplied by 3985, the number of miles contained in the earth's semidiameter, will give the number of miles by which the sun is distant from the earth's center.

Then

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Then, As 100,000, the earth's mean distance from the sun in parts, is to 38,710, Mercury's mean distance from the sun in parts, so is the earth's mean distance from the sun in miles to Mercury's mean distance from the sun in miles.—And,

397 Distances of the other planets, how found.

As 100,000 is to 72,333, so is the earth's mean distance from the sun in miles to Venus's mean distance from the sun in miles.—Likewise,

As 100,000 is to 152,369, so is the earth's mean distance from the sun in miles to Mars's mean distance from the sun in miles.—Again,

As 100,000 is to 520,096, so is the earth's mean distance from the sun in miles to Jupiter's mean distance from the sun in miles. Lastly,

As 100,000 is to 954,006, so is the earth's mean distance from the sun in miles to Saturn's mean distance from the sun in miles.

And thus, by having found the distance of any one of the planets from the sun, we have sufficient data for finding the distances of all the rest. And then from their apparent diameters at these known distances, their real diameters and bulks may be found. According to the calculations made from the transit in 1769, we have given the distance of each of the primary and secondary planets from one another, and from the sun, in fig. 119. In fig. 153. their proportional bulks are shown, according to former culculations by Mr Ferguson; and in fig. 18. their relative magnitudes according to the latest calculations by Mr Dunn. The proportional distances of the satellites of Jupiter and Saturn, with the magnitudes of the sun, and orbit of our moon, by Mr Ferguson, are represented fig. 186.

398 Distances of the fixed stars immeasurable.

With regard to the fixed stars, no method of ascertaining their distance hath hitherto been found out. Those who have formed conjectures concerning them, have thought that they were at least 400,000 times farther from us than we are from the sun.

399 Why they seem so big to our naked eye.

They are said to be fixed, because they have been generally observed to keep at the same distances from each other; their apparent diurnal revolutions being caused solely by the earth's turning on its axis. They appear of a sensible magnitude to the bare eye, because the retina is affected not only by the rays of light which are emitted directly from them, but by many thousands more, which falling upon our eye-lids, and upon the aerial particles about us, are reflected in our eyes so strongly as to excite vibrations not only in those points of the retina where the real images of the stars are formed, but also in other points at some distance round about. This makes us imagine the stars to be much bigger than they would appear if we saw them only by the few rays which come directly from them, so as to enter our eyes without being intermixed with others. Any one may be sensible of this, by looking at a star of the first magnitude through a long narrow tube; which, though it takes in as much of the sky as would hold 1000 such stars, yet scarce renders that one visible.

The more a telescope magnifies, the less is the aperture through which the star is seen; and consequently the fewer rays it admits into the eye. Now, since the stars appear less in a telescope which magnifies 200 times, than they do to the bare eye, insomuch that they seem to be only indivisible points, it proves at once that the stars are at immense distances from us, and that they shine by their own proper light. If they shone by borrowed light, they would be as invisible without telescopes as the satellites of Jupiter are; for these satellites appear bigger when viewed with a good telescope than the largest fixed stars do.

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Dr. Herschel has proposed a method of ascertaining the parallax of the fixed stars, something similar, but more complete, than that mentioned by by Galileo and others; for it is by the parallax of the fixed stars that we should be best able to determine their distance. The method pointed out by Galileo; and first attempted by Hook, Flamstead, Mollineux and Bradley, of taking distances of stars from the zenith that pass very near it, has given us a much juster idea of the immense distance of the stars, and furnished us with an approximation to the knowledge of their parallax, that is much nearer the truth than we ever had before. But Dr Herschel mentions the insufficiency of their instruments, which were similar to the present zenith sectors, the method of zenith distances being liable to considerable errors on account of refraction, the change of position of the earth's axis arising from nutation, precession of the equinoxes, and other causes, and the aberration of light. The method of his own is by means of double stars; which is exempted from these errors, and of such a nature that the annual parallax, even if it should not exceed the tenth part of a second, may still become more visible, and be ascertained, at least to a much greater degree of approximation than it has ever been done. This method is capable of every improvement which the telescope and mechanism of micrometers can furnish. The method and its theory will be seen by the following investigation, extracted from his paper on the subject. Let O, E. (fig. 164.) be two opposite points in the annual orbit, taken in the same plane with two stars *a*, *b*, of unequal magnitudes. Let the angle *a* O *b* be observed when the earth is at O, and *a* E *b* be observed when the earth is at E. From the difference of these angles, if there should be any, we may calculate the parallax of the stars, according to the theory subjoined. These two stars ought to be as near each other as possible, and also to differ as much in magnitude as we can find them. *Phil. Tran.* vol. lxxii. p. 82.

Dr Herschel's theory of the annual parallax of double stars, with the method of computing from thence what is generally called the parallax of the fixed stars, or of single stars of the first magnitude, such are nearest to us, supposes, *first*, that the stars, one with another, are about the size of the sun; and, *secondly*, that the difference of their apparent magnitude is owing to their different distances; so that the star of the second, third, or fourth magnitude, is two, three, or four times as far off as one of the first. These principles, which he premises as postulata, have so great a probability in their favour, that they will hardly be objected to by those who are in the least acquainted with the doctrine of chances. Accordingly, let OE (fig. 165.) be the whole diameter of the earth's annual orbit; and let *a*, *b*, *c*, be three stars situated in the ecliptic, in such a manner that they may be seen all in one line O *a*, *b*, *c*, when the earth is at O. Let the line O *a b c* be perpendicular to OE. and draw PE parallel to *c* O: then, if O *a*, *a b*, *b c*, are equal to each other, *a* will be a star of the first magnitude, *b* of the second, and *c* of

ASTRONOMY

Plate LXXXI

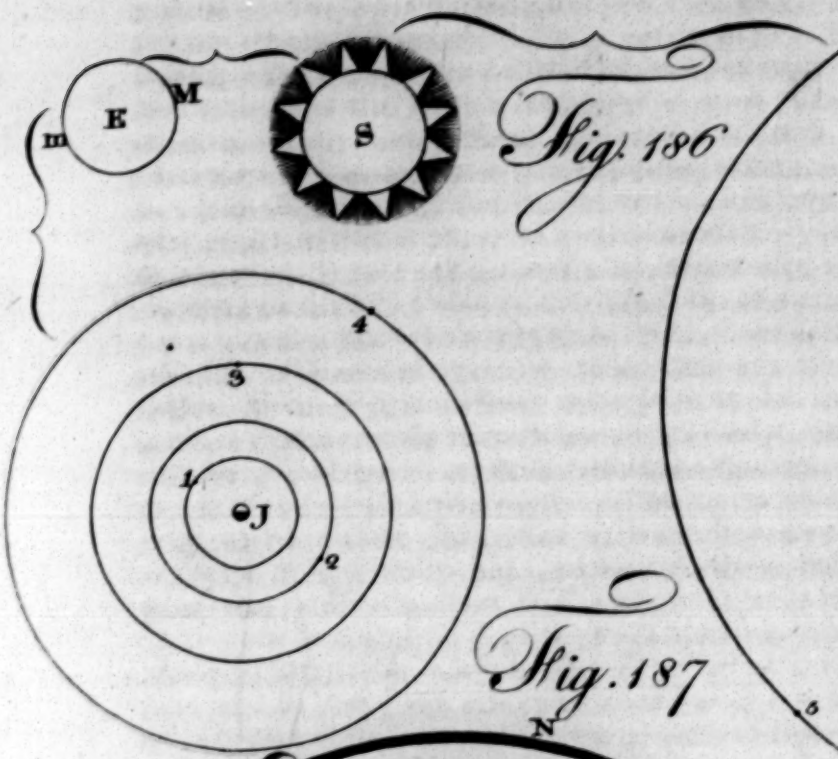


Fig. 186

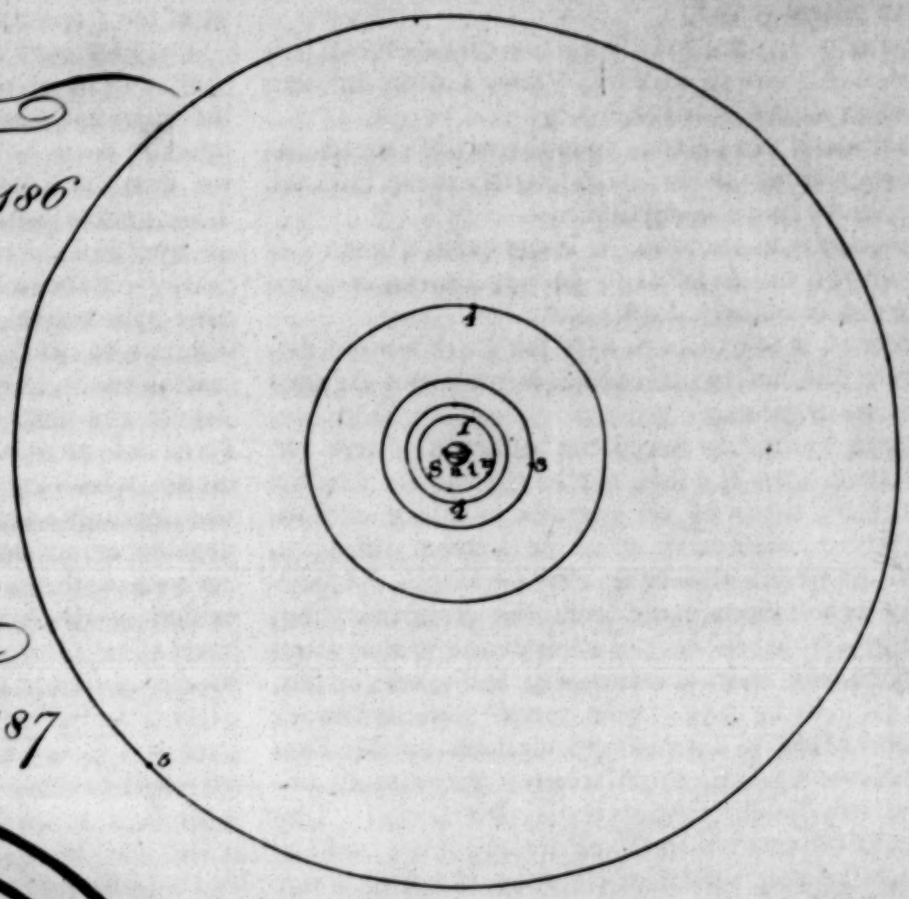


Fig. 187

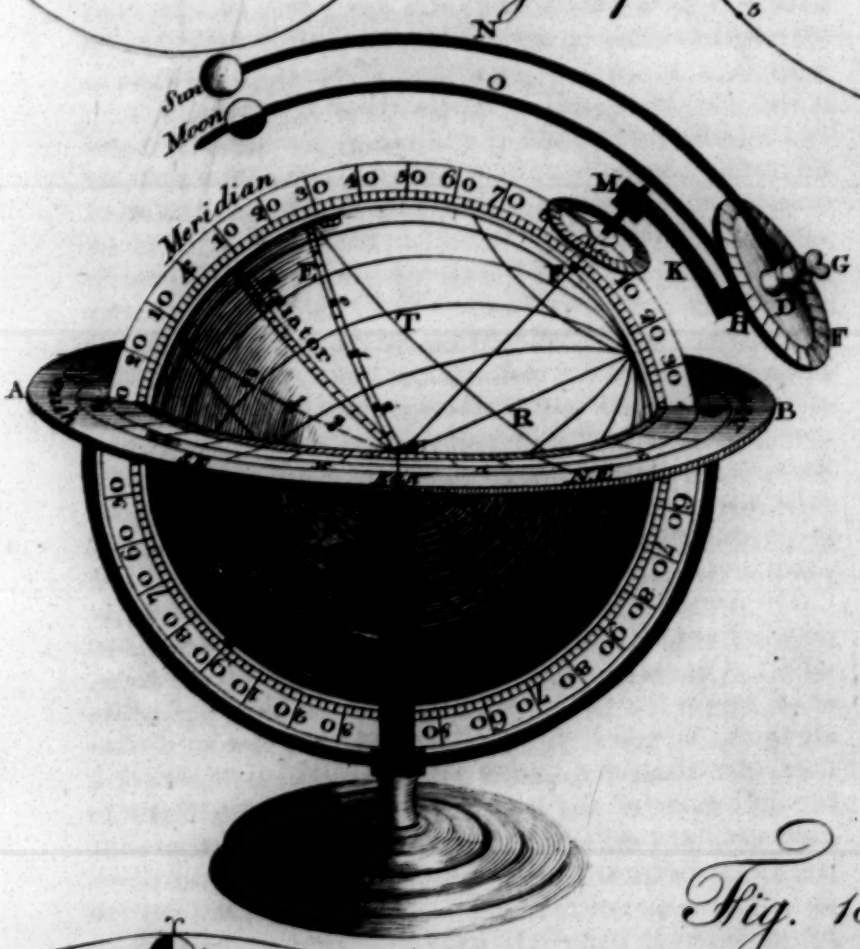


Fig. 188

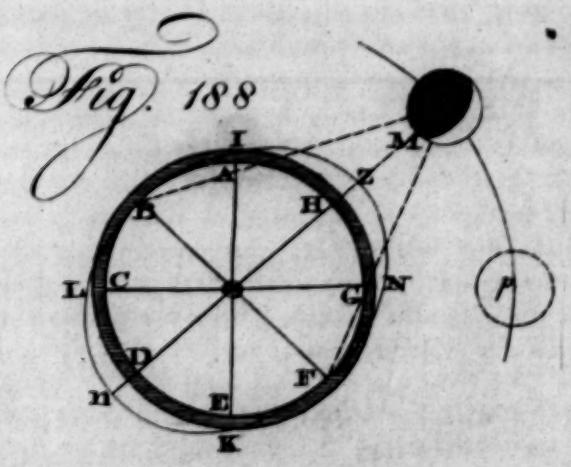
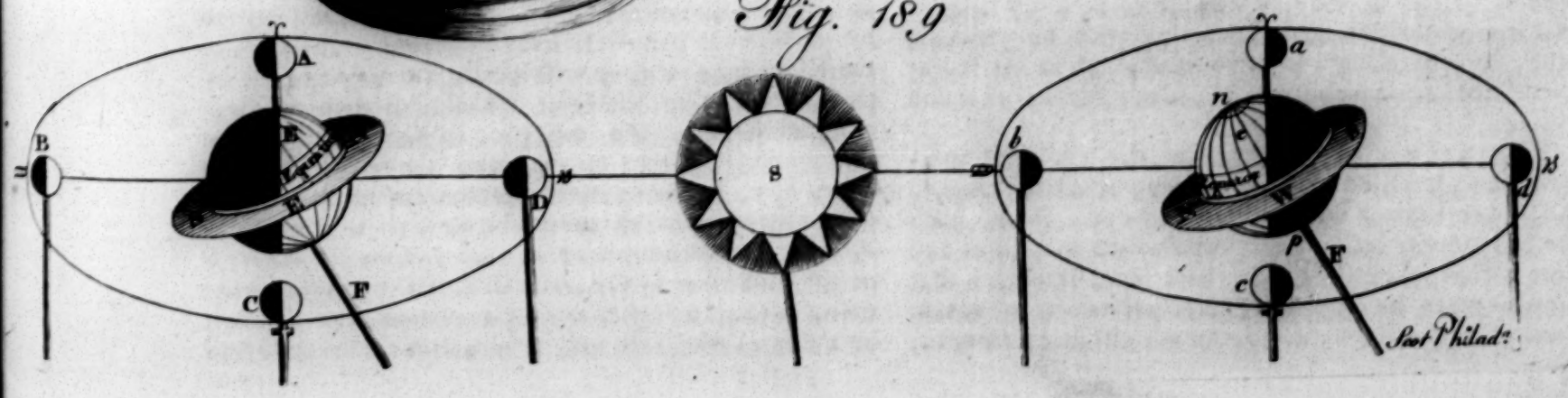


Fig. 189



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c of the third. Let us now suppose the angle O a E, or parallax of the whole orbit of the earth, to be 1″ of a degree; then we have P E a = O a E = 1″: and because very small angles, having the same subtense OE, may be taken to be in the inverse ratio of the lines O a, O b, O c, &c. we shall have O b E = ½″, O c E = ⅓″, &c. Now when the earth is removed to E, we shall have P E b = E b o = ½″, and P E a — P E b = a E b = ½″: i. e. the stars a, b, will appear to be ½″ distant. We also have P E c = E c O = ½″, and P E a — P E c = a E c = ½″; i. e. the stars a, c, will appear to be ½″ distant when the earth is at E. Now, since we have b E P = ½″, and c E P = ⅓″, therefore b E P — c E P = b E c = ½″ — ⅓″ = ⅙″; i. e. the stars b, c, will appear to be only ⅙″ removed from each other when the earth is at E. Whence we may deduce the following expression, to denote the parallax that will become visible in the change of distance between the two stars, by the removal of the earth from one extreme of its orbit to the other. Let P express the total parallax of a fixed star of the first magnitude, M the magnitude of the largest of the two stars, m the magnitude of the smallest, and p the partial parallax to be observed by the change in the distance of a double star; then will $p = \frac{m-M}{M\,m}$ P; and p, being found by observation, will give us $P = \frac{p\,M\,m}{m-M}$. *E. G.* Suppose a star of the first magnitude should have a small star of the twelfth magnitude near it; then will the partial parallax we are to expect to see be $\frac{12 \times 1\ P}{12-1}$, or $\frac{1}{11}$ of the total parallax of a fixed star of the first magnitude; and if we should, by observation, find the partial parallax between two such stars to amount to 1″, we shall have the total parallax $P = \frac{1 \times 1 \times 12}{12-1} = 1''.0909$. If the stars are of the third and twenty-fourth magnitude, the partial parallax will be $\frac{24-3}{3 \times 24} = \frac{21}{72}$ P; and if, by observation, p is found to be a tenth of a second, the whole parallax will come out $\frac{.1 \times 3 \times 24}{24-3} = 0''.3428$.

Farther, suppose the stars being still in the ecliptic, to appear in one line, when the earth is in any other part of its orbit between O and E; then will the parallax still be expressed by the same algebraic formula, and one of the maxima will still lie at O, the other at E; but the whole effect will be divided into two parts, which will be in proportion to each other as radius — sine to radius + sine of the stars distance from the nearest conjunction or opposition.

When the stars are any where out of the ecliptic, situated so as to appear in one line O a b c perpendicular to O E, the maximum of parallax will still be expressed by $\frac{m-M}{M\,m}$ P; but there will arise another additional parallax in the conjunction and opposition, which will be to that which is found 90° before or after the sun, as the sine (S) of the latitude of the stars seen at O is to the radius (R); and the effect of this parallax will be divided into two parts; half of it lying on one side of the large star, the other half on the other side of it. This latter parallax, moreover, will be compounded with the former, so that the distance of the stars in the conjunction and opposition will then be represented by the diagonal of a parallelogram, whereof the two semiparallaxes are the sides; a general expression for which will be $\sqrt{\frac{m-M}{2\,m\,M}\,P\Big|^2 \times \frac{SS}{RR} + 1}$; for the stars will apparently describe two ellipses in the heavens, whose transverse axis will be to each other in the ratio of M to m (fig. 167.), and A a, B b, C c, D d, will be the cotemporary situations. Now, if b Q be drawn parallel to A C, and the parallelogram $b\,q$ B Q be completed, we shall have b Q = ¼ C A — ¼ $c\,a$ = ¼ C c = ¼ p, or semiparallax 90° before or after the sun, and B b may be resolved into, or is compounded of, b Q and $b\,q$; but $b\,q$ = ¼ B D — ¼ $b\,d$ = the semiparallax in the conjunction or opposition. We also have R : S : : b Q : $b\,q = \frac{p\,S}{2\,R}$; therefore the distance B b (or D d) $= \sqrt{\frac{p}{2}\Big|^2 + \frac{p\,S}{2\,R}\Big|^2}$; and by substituting the value of p into this expression, we obtain $\sqrt{\frac{m-M}{2\,M\,m}\,P\Big|^2 \times \frac{S\,S}{RR} + 1}$, as above. When the stars are in the pole of the ecliptic, $b\,q$ will become equal to b Q, and B b will be 7071 $P\frac{m-M}{M\,m}$. Again, let the stars be at some distance, *e. g.* 5″ from each other, and let them both be in the ecliptic. This case is resolvable into the first; for imagine the star a (fig. 166.) to stand at x, and in that situation the stars x, b, c, will be in one line, and their parallax expressed by $\frac{m-M}{M\,m}$ P. But the angle a E x may be taken to be equal to a O x; and as the foregoing formula gives us the angles x E b, x E c, we are to add a E x or 5″ to x E b, and we shall have a E b. In general, let the distance of the stars be d, and let the observed distance at E be D, then will $D = d + p$, and therefore the whole parallax of the annual orbit will be expressed by $\frac{D\,M\,m - d\,M\,m}{m-M} = P$.

Suppose the two stars now to differ only in latitude, one being in the ecliptic, the other, *e. g.* 5 north, when seen at O. This case may also be resolved by the former; for imagine the stars b, c, (fig. 165.) to be elevated at right angles above the plane of the figure, so that a O b, or a O c, may make an angle of 5″ at O; then, instead of the lines O a b c, E a, E b, E c, E P, imagine them all to be planes at right angles to the figure; and it will appear that the parallax of the stars in longitude must be the same as if the small star had been without latitude. And since the stars b, c, by the motion of the earth from O to E, will not change their latitude, we shall have the following construction for finding the distance of the stars a b, a c, at E, and from thence the parallax P. Let the triangle a b β (fig. 168.) represent the situation of the stars; a b is the subtense of 5″, the angle under which they are supposed to be seen at O. The quantity $b\,\beta$ by the former theorem is found, $\frac{m-M}{M\,m}$ P, which is the partial parallax that would have been seen by the

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earth's moving from O to E, if both ſtars had been in the ecliptic; but on account of the difference in latitude, it will be now repreſented by $a\beta$, the hypothenuſe of the triangle $a\,b\,\beta$: therefore, in general, putting $a\,b = d$, and $a\,\beta = D$, we have $\sqrt{\frac{D\,D - d\,d \times M\,m}{m - M}} = P$. Hence D being taken by obſervation, and d, M, and m, given, we obtain the total parallax.

If the ſituation of the ſtars differs in longitude as well as latitude, we may reſolve this caſe by the following method. Let the triangle $a\,b\,\beta$ (fig. 169.) repreſent the ſituation of the ſtars, $a\,b = d$ being their diſtance ſeen at O, $a\,\beta = D$ their diſtance ſeen at E. That the change $b\,\beta$, which is produced by the earth's motion will be truly expreſſed by $\frac{m - M}{M\,m}P$ may be proved as before, by ſuppoſing the ſtar a to have been placed at α. Now let the angle of poſition $b\,a\,\alpha$ be taken by a micrometer, or by any other method ſufficiently exact; then, by ſolving the triangle $a\,b\,\alpha$, we ſhall have the longitudinal and latitudinal differences $a\,\alpha$ and $b\,\alpha$ of the two ſtars, Put $a\,\alpha = x$, $b\,\alpha = y$, and it will be $x + b\,\beta = aq$, whence $D = \sqrt{\left(x + \frac{m - M}{M\,m}P\right)^2 + y\,y}$; and $\frac{\sqrt{D^2 - y^2} \times M^2 m - x M m}{m - M} = P$.

If neither of the ſtars ſhould be in the ecliptic, nor have the ſame longitude or latitude, the laſt theorem will ſtill ſerve to calculate the total parallax whoſe maximum will lie in E. There will, moreover, ariſe another parallax, whoſe maximum will be in the conjunction and oppoſition, which will be divided, and lie on different ſides of the large ſtar; but as we know the whole parallax to be exceedingly ſmall, it will not be neceſſary to inveſtigate every particular caſe of this kind; for by reaſon of the diviſion of the parallax, which renders obſervations taken at any other times, except where it is greateſt, very unfavourable, the formulæ would be of little uſe. Dr Herſchel cloſes his account of this theory with a general obſervation on the time and place where the maxima of parallax will happen.

When two unequal ſtars are both in the ecliptic, or, not being in the ecliptic, have equal latitudes, north or ſouth; and the largeſt ſtar has moſt longitude, the maximum of the apparent diſtance will be when the ſun's longitude is 90 degrees more than the ſtars, or when obſerved in the morning; and the maximum when the longitude of the ſun is 90 degrees leſs than that of the ſtars, or when obſerved in the evening. When the ſmall ſtar has moſt longitude, the maximum and minimum, as well as the time of obſervation, will be the reverſe of the former. When the ſtars differ in latitudes, this makes no alteration in the place of the maximum or minimum, nor in the time of obſervation; i. e. it is immaterial whether the largeſt ſtar has the leaſt or the greateſt diſtance of the two ſtars.

400 Different magnitudes of the ſtars.

The ſtars, on account of their apparently various magnitudes, have been diſtributed into ſeveral claſſes, or orders. Thoſe which appear largeſt are called *ſtars of the firſt magnitude*; the next to them in luſtre, *ſtars of the ſecond magnitude*; and ſo on to the *ſixth*, which are the ſmalleſt that are viſible to the bare eye. This diſtribution having been made long before the invention of teleſcopes, the ſtars which cannot be ſeen without the aſſiſtance of theſe inſtruments are diſtinguiſhed by the name of *teleſcopic ſtars*.

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401 Teleſcopic ſtars.

The ancients divided the ſtarry ſphere into particular conſtellations, or ſyſtems of ſtars, according as they lay near one another, ſo as to occupy thoſe ſpaces which the figures of different ſorts of animals or things would take up, if they were there delineated. And thoſe ſtars which could not be brought into any particular conſtellation were called *unformed ſtars*.

402 Unformed ſtars.

402 Uſe of their diviſion into conſtellations.

This diviſion of the ſtars into different conſtellations, or aſteriſms, ſerves to diſtinguiſh them from one another, ſo that any particular ſtar may be readily fodnd in the heavens by means of a celeſtial globe; on which the conſtellations are ſo delineated as to put the moſt remarkable ſtars into ſuch parts of the figures as are moſt eaſily diſtinguiſhed. The number of the ancient conſtellations is 48, and upon our preſent globes about 70. On Senex's globes are inſerted Bayer's letters; the firſt in the Greek alphabet being put to the biggeſt ſtar in each conſtellation, the ſecond to the next, and ſo on: by which means, every ſtar is as eaſily found as if a name were given to it. Thus, if the ſtar γ in the conſtellation of the ram be mentioned, every aſtronomer knows as well what ſtar is meant as if it were pointed out to him in the heavens. See fig. 205, 206. where the ſtars are repreſented with the figures of the animals from whence the conſtellations are marked.

404 Diviſion of the heavens. Fig. 26, 29.

There is alſo a diviſion of the heavens into three parts. 1. The zodiac (ζωδιακος), from ζωδιον *zodion*, "an animal," becauſe moſt of the conſtellations in it, which are 12 in number, have the names of animals: As *Aries* the ram, *Taurus* the bull, *Gemini* the twins, *Cancer* the crab, *Libra* the balance, *Scorpio* the ſcorpion, *Sagittarius* the archer, *Capricornus* the goat, *Aquarius* the water-bearer, and *Piſces* the fiſhes. The zodiac goes quite round the heavens: it is about 16 degrees broad, ſo that it takes in the orbits of all the planets, and likewiſe the orbit of the moon. Along the middle of this zone or belt is the ecliptic, or circle which the earth deſcribes annually as ſeen from the ſun, and which the ſun appears to deſcribe as ſeen from the earth. 2. All that region of the heavens which is on the north ſide of the zodiac, containing 21 conſtellations. And, 3. That on the ſouth ſide, containing 15.

405 Zodiac how divided.

The ancients divided the zodiac into the above 12 conſtellations or ſigns in the following manner. They took a veſſel with a ſmall hole in the bottom, and, having filled it with water, ſuffered the ſame to diſtil drop by drop into another veſſel ſet beneath to receive it; beginning at the moment when ſome ſtar roſe, and continuing till it roſe the next following night. The water falling down into the receiver, they divided into twelve equal parts; and having two other ſmall veſſels in readineſs, each of them fit to contain one part, they again poured all the water into the upper veſſel; and, obſerving the riſing of ſome ſtar in the zodiac, they at the ſame time ſuffered the water to drop into one of the ſmall veſſels; and as ſoon as it was full, they ſhifted it, and ſet an empty one in its place. When each veſſel was full, they took notice what ſtar of the zodiac roſe; and though this could not be done in

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in one night, yet in many they obſerved the riſing of 12 ſtars or points, by which they divided the zodiac into 12 parts.

The name of the conſtellations, and the number of ſtars obſerved in each of them by different aſtronomers, are as follow.

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The ancient Conſtellations.		*Ptolemy.*	*Tycho.*	*Hevelius.*	*Flamſtead.*
Urſa minor	The Little Bear	8	7	12	24
Urſa major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, *Arctophilax*		23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, *Engonaſin*	Hercules kneeling	29	28	45	113
Lyra	The Harp	10	11	17	21
Cygnus, *Gallina*	The Swan	10	18	47	81
Caſſiopeia	The Lady in her Chair	13	26	37	55
Perſeus	Perſeus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, *Opiuchus*	Serpentarius	29	15	40	74
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, *Vultur*	The Eagle }	15	12	23	71
Antinous	Antinous }		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, *Equi ſectio*	The Horſe's Head	4	4	6	10
Pegaſus, *Equus*	The Flying Horſe	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16
Aries	The Ram	18	21	27	66
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion }	35	30	49	95
Coma Berenices	Berenice's Hair }		14	21	43
Virgo	The Virgin	32	33	50	110
Libra, *Chelæ*	The Scales	17	10	20	51
Scorpius	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Piſces	The Fiſhes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, *Fluvius*	Eridanus, *the River*	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis major	The Great Dog	29	13	21	31
Canis minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	4	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4		9
Centaurus	The Centaur	37			35
Lupus	The Wolf	19			24
Ara	The Altar	7			9
Corona Auſtralis	The Southern Crown	13			12
Piſces Auſtralis	The Southern Fiſh	18			24

406 Catalogue of the conſtellations.

The new Southern Conſtellations.				
Columba Noachi	Noah's Dove	10	Apus, *Avis Indica*	The Bird of Paradiſe 11
Robur Carolinum	The Royal Oak	12	Apis, *Muſca*	The Bee or Fly 4
Grus	The Crane	13	Chamæleon	The Chameleon 10
Phœnix	The Phenix	13	Triangulum Auſtralis	The South Triangle 5
Indus	The Indian	12	Piſcis volans, *Paſſer*	The Flying Fiſh 8
Pavo	The Peacock	14	Dorado, *Xiphias*	The Sword Fiſh 6
			Toucan	The American Gooſe 9
			Hydrus	The Water Snake 10

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Hevelius's Conſtellations made out of the unformed Stars.

		Hevel.	*Flamſt.*
Lynx	The Lynx	19	44
Leo minor	The Little Lion		53
Aſterion & Chara	The Greyhounds	23	25
Cerberus	Cerberus	4	
Vulpecula & Anſer	The Fox and Gooſe	27	35
Scutum Sobieſki	Sobieſki's Shield	7	
Larcerta	The Lizard	10	16
Camelopardalus	The Camelopard	32	58
Monocerns	The Unicorn	19	31
Sextans	The Sextant	11	41

407 Change in the obliquity of the ecliptic.

The obliquity of the ecliptic to the equinoctial is found at preſent to be above the third part of a degree leſs than Ptolemy found it. And moſt of the obſervers after him found it to decreaſe gradually down to Tycho's time. If it be objected, that we cannot depend on the obſervations of the ancients, becauſe of the incorrectneſs of their inſtruments; we have to anſwer, that both Tycho and Flamſtead are allowed to have been very good obſervers; and yet we find that Flamſtead makes this obliquity 2½ minutes of a degree leſs than Tycho did about 100 years before him: and as Ptolemy was 1324 years before Tycho, ſo the gradual decreaſe anſwers nearly to the difference of time between theſe three aſtronomers. If we conſider, that the earth is not a perfect ſphere, but an oblate ſpheroid, having its axis ſhorter than its equatorial diameter; and that the ſun and moon are conſtantly acting obliquely upon the greater quantity of matter about the equator, pulling it, as it were, towards a nearer and nearer coincidence with the ecliptic; it will not appear improbable that theſe actions ſhould gradually diminiſh the angle between thoſe planes. Nor is it leſs probable that the mutual attractions of all the planets ſhould have a tendency to bring their orbits to a coincidence: but this change is too ſmall to become ſenſible in many ages.

Sect. IX. *Of calculating the periodical Times, Places, &c. of the Sun, Moon, and Planets: Delineation of the Phaſes of the Moon for any particular Time; and the Conſtruction of Aſtronomical Tables.*

This title includes almoſt all of what may be called the *Practical part of Aſtronomy*; and as it is by far the moſt difficult and abſtruſe, ſo the thorough inveſtigation of it would neceſſarily lead us into very deep geometrical demonſtrations. The great labours of former aſtronomers have left little for ſucceeding ones to do in this reſpect: tables of the motions of all the celeſtial bodies have been made long ago, the periodical times, eccentricities, &c. of the planets determined; and as we ſuppoſe few will deſire to repeat theſe laborious operations, we ſhall here content ourſelves with giving ſome general hints of the methods by which theſe things have been originally accompliſhed, that ſo the operations of the young aſtronomer who makes uſe of tables already formed to his hand may not be merely mechanical.

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It hath been already obſerved, that the foundation of all aſtronomical operations was the drawing a meridian line. This being done, the next thing is to find out the latitude of the place where the obſervations are to be made, and for which the meridian line is drawn. From what hath been ſaid, n° 39. it will eaſily be underſtood that the latitude of a place muſt always be equal to the elevation either of the north or ſouth pole above the horizon; becauſe when we are exactly on the equator, both poles appear on the horizon. There is, however, no ſtar exactly in either of the celeſtial poles; therefore, to find the altitude of that inviſible point called the *Pole of the heavens*, we muſt choſe ſome ſtar near it which does not ſet; and having by ſeveral obſervations, according to the directions given n° 377, found its greateſt and leaſt altitudes, divide their difference by 2; and half that difference added to the leaſt, or ſubtracted from the greateſt, altitude of the ſtar, gives the exact altitude of the pole or latitude of the place. Thus, ſuppoſe the greateſt altitude of the ſtar obſerved is 60° and its leaſt 50°, we then know that the altitude of the place where the obſervation was made is exactly 55°.

308 Latitude of any place how found.

409 Obliquity of the ecliptic found.

The latitude being once found, the obliquity of the ecliptic, or the angle made by the ſun's annual path with the earth's equator, is eaſily obtained by the following method. Obſerve, about the ſummer ſolſtice, the ſun's meridian diſtance from the zenith, which is eaſily done by a quadrant with a moveable index furniſhed with ſights; if this diſtance is ſubtracted from the latitude of the place, provided the ſun is nearer the equator than the place of obſervation, the remainder will be the obliquity of the ecliptic: But if the place of obſervation is nearer the equator than the ſun at that time, the zenith diſtance muſt be added. By this method, the obliquity of the ecliptic hath been determined to be 23° 29′.

410 Sun's declination.

By the ſame method the declination of the ſun from the equator for any day may be found; and thus a table of his declination for every day in the year might be conſtructed: thus alſo the declination of the ſtars might be found.

411 His place in the ecliptic how found. Fig. 156.

Having the declination of the ſun, his right aſcenſion and place in the ecliptic may be geometrically found by the ſolution of a caſe in ſpherical trigonometry. For let EQ repreſent the celeſtial equator, *y* the ſun, and *y* X the ecliptic; then, in the right-angled ſpherical triangle EC*y*, we have the ſide E*y*, equal to the ſun's declination: the angle EC*y* is always 23° 29′, being the angle of the ecliptic with the equator; and the angle *y*EC is 90°, or a right angle. From theſe data we can find the ſide EC the right aſcenſion; and C*y* the ſun's place in the ecliptic, or his diſtance from the equinoctial point; and thus a table of the ſun's place for every day in the year, anſwerable to his declination, may be formed.

412 To find the right aſcenſion of the ſtars.

Having the ſun's place in the ecliptic, the right aſcenſion of the ſtars may be found by the help of it and a good pendulum clock: For which purpoſe, the motion of the clock muſt be ſo adjuſted that the hand may run through the 24 hours in the ſame time that a ſtar leaving the meridian will arrive at it again; which time is ſomewhat ſhorter than the natural day, becauſe of the ſpace the ſun moves through in the mean time eaſtward.

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ward. The clock being thus adjuſted, when the ſun is in the meridian, fix the hand to the point from whence we are to begin to reckon our time; and then obſerve when the ſtar comes to the meridian, and mark the hour and minute that the hand then ſhows: The hours and minutes deſcribed by the index, turned into degrees and minutes of the equator, will give the difference between the right aſcenſion of the ſun and ſtars; which difference, being added to the right aſcenſion of the ſun will give the right aſcenſion of the ſtar. Now, if we know the right aſcenſion of any one ſtar, we may from it find the right aſcenſions of all the others which we ſee, by marking the time upon the clock between the arrival of the ſtar whoſe right aſcenſion we know to the meridian, and another ſtar whoſe aſcenſion is to be found. This time converted into hours and minutes of the equator, will give the difference of right aſcenſions; from whence, by addition, we collect the right aſcenſion of the ſtar which was to be found out.

413 Their longitudes and latitudes found.

The right aſcenſion and declination of a ſtar being known, its longitude and latitude, or diſtance from the firſt ſtar of Aries, and north or ſouth from the ecliptic, may thence be eaſily found, from the ſolution of a caſe in ſpherical trigonometry, ſimilar to that already mentioned concerning the ſun's place; and the places of the fixed ſtars being all marked in a catalogue according to their longitudes and latitudes, it may thence be conceived how the longitude and latitude of a planet or a comet may be found for any particular time by comparing its diſtances from them, and it apparent path may thus be traced; and thus the paths of Mercury and Venus were traced by M. Caſſini, though Mr Ferguſon made uſe of an orrery for that purpoſe.

414 To find the periodical times of the planets.

With regard to the planets, the firſt thing to be done is to find out their periodical times, which is done by obſerving when they have no latitude. At that time the planet is in the ecliptic, and conſequently in one of its nodes; ſo that by waiting till it returns to the ſame node again, and keeping an exact account of the time, the periodical time of its revolution round the ſun may be known pretty exactly. By the ſame obſervations, from the theory of the earth's motion we can find the poſition of the line of the nodes; and when once the poſition of this line is found, the angle of inclination of that planet's orbit to the earth may alſo be known.

415 Eccentricity of the earth's orbit how determined.

The eccentricity of the earth's orbit may be determined by obſerving the apparent diameters of the ſun at different times: when the ſun's diameter is leaſt, the earth is at the greateſt diſtance; and when this diameter is greateſt, the earth is at its leaſt diſtance from him. But as this method muſt neceſſarily be precarious, another is recommended by Dr Keil, by obſerving the velocity of the earth in its orbit, or the apparent velocity of the ſun, which is demonſtrated to be always reciprocally as the ſquare of the diſtance.

416 Of the other planets.

The eccentricities of the orbits of the other planets may be likewiſe found by obſerving their velocities at different times; for all of them obſerve the ſame proportions with regard to the increaſe or decreaſe of their velocity that the earth does; only, in this caſe, care muſt be taken to obſerve the real, not the apparent, velocities of the planets, the laſt depending on the motion of the earth at the ſame time. Their aphelia, or points of their orbits where they are fartheſt from the ſun, may be known by making ſeveral obſervations of their diſtances from him, and thus perceiving when theſe diſtances ceaſe to increaſe.

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The poſition of the aphelion being determined, the planet's diſtance from it at any time may alſo be found by obſervation, which is called its *true* or *coequated* anomaly; but by ſuppoſing the motion of the planet to be regular and uniform, tables of that motion may be eaſily conſtructed. From thence the planet's mean place in its orbit may be found for any moment of time; and one of theſe moments being fixed upon as an epocha or beginning of the table, it is eaſy to underſtand, that from thence tables of the planet's place in its orbit for any number of years either preceding or conſequent to that period may be conſtructed. Theſe tables are to be conſtructed according to the meridian of equal time, and not true or apparent time, becauſe of the inequalities of the earth's motion as well as that of the planet, and equations muſt be made to be added to or ſubtracted from the mean motion of the planet as occaſion requires; which will be readily underſtood from what we have already mentioned concerning the unequal motion of the earth in its orbit. When all the neceſſary tables are conſtructed by this or ſimilar methods, the calculating of the planetary places becomes a mere matter of mechaniſm, and conſiſts only in the proper additions and ſubtractions according to the directions always given along with ſuch tables.

417 To find their places in their orbits.

418 Inaccuracies from the mutual attraction of the planets.

It muſt be obſerved, however, that the accidental interference of the planets with one another by their mutual attractions render it impoſſible to conſtruct any tables that ſhall remain equally perfect; and therefore frequent actual obſervations and corrections of the tables will be neceſſary. This diſturbance, however, is inconderable, except in the planets Jupiter and Saturn, and they are in conjunction only once in 800 years.

419 Difficulties with regard to the moon.

What hath been already mentioned with regard to the planets, is alſo applicable to the moon; but with more difficulty, on account of the greater inequalities of her motions, the cauſe of which has been already explained. She indeed moves in an ellipſe as the reſt do, and its eccentricity may be better computed from obſerving her diameter at different times than that of the earth's orbit; but that eccentricity is not always the ſame. The reaſon of this, and indeed of all the other lunar inequalities, is, that the ſun has a ſenſible effect upon her by his attraction, as well as the earth. Conſequently, when the earth is at its leaſt diſtance from the ſun, her orbit is dilated, and ſhe moves more ſlowly; and, on the contrary, when the earth is in its aphelion, her orbit contracts, and ſhe moves more ſwiftly. The eccentricity is always greateſt when the line of the apſides coincides with that of the ſyzygies, and the earth at its leaſt diſtance from the ſun. When the moon is in her ſyzygies, i. e. in the line that joins the centres of the earth and ſun, which is either in her conjunction or oppoſition, ſhe moves ſwifter, *cæteris paribus*, than in the quadratures. According to the different diſtances of the moon from the ſyzygies, ſhe changes her motion: from the conjunction to her firſt quadrature, ſhe moves ſomewhat ſlower; but recovers her velocity in the ſecond quarter. In the third quarter ſhe again loſes, and in the laſt again recovers it.

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The apogeon of the moon is alſo irregular; being found to move forward when it coincides with the line of the ſyzygies, and backwards whent it cuts that line at right angles. Nor is this motion in any degree equal: in the conjunction or oppoſition, it goes briſkly forwards, and in the quadratures moves either ſlowly forwards, ſtands ſtill, or goes backward. The motion of the nodes has been already taken notice of: but this motion is not uniform more than the reſt; for when the line of the nodes coincides with that of the ſyzygies, they ſtand ſtill; when their line cuts that at right angles, they go backwards with the velocity, as Sir Iſaac Newton hath ſhown, of 16″ 19‴ 24⁗ an hour.

420 Moves equably on her axis.

The only equable motion the moon has, is her revolution on her axis, which ſhe always performs exactly in the ſpace of time in which ſhe moves round the earth. From hence ariſes what is called the *moon's libration*; for as the motion round her axis is equable, and that in her orbit unequal, it follows, that when the moon is in her perigee, where ſhe moves ſwifteſt, that part of her ſurface, which on account of the motion in her orbit would be turned from the earth, is not ſo, by reaſon of the motion on her axis. Thus ſome parts in the limb or margin of the moon ſometimes recede from, and ſometimes approach towards, the centre of the diſk. Yet this equable rotation produces an apparent irregularity; for the axis of the moon not being perpendicular but a little inclined to its orbit, and this axis maintaining its parallelism round the earth, it muſt neceſſarily change its ſituation with reſpect to an obſerver on the earth, to whom ſometimes the one and ſometimes the other pole of the moon becomes viſible; whence it appears to have a kind of wavering or vacillatory motion.

421 Lunar irregularities accounted for by Sir Iſaac Newton.

From all theſe irregularities it may well be concluded, that the calculation of the moon's place in her orbit is a very difficult matter; and indeed, before Sir Iſaac Newton, aſtronomers in vain laboured to ſubject the lunar irregularities to any rule. By his labours, however, and thoſe of other aſtronomers, theſe difficulties are in a great meaſure overcome; and calculations with regard to this luminary may be made with as great certainty as concerning any other.

422 Her periodical time determined by Copernicus.

Her periodical time may be determined from the obſervation of two lunar eclipſes, at as great a diſtance from one another as poſſible; for in the middle of every lunar eclipſe, the moon is exactly in oppoſition to the ſun. Compute the time between theſe two eclipſes or oppoſitions, and divide this by the number of lunations that have intervened, and the quotient will be the ſynodical month, or time the moon takes to paſs from one conjunction to another, or from one oppoſition to another. Compute the ſun's mean motion in the time of the ſynodical month, and add this to the entire circle deſcribed by the moon. Then, As that ſum is to 360°, ſo is the quantity of the ſynodical month to the periodical, or time that the moon takes to move from one point of her orbit to the ſame point again. Thus, Copernicus, in the year 1500, November 6th, at 2 hours 20 minutes, obſerved an eclipſe of the moon at Rome; and Auguſt 1ſt 1523, at 4 hours 25 minutes, another at Cracow: hence the quantity of the ſynodical month is thus determined

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	Y.	D.	H.	M.
Obſerv. 2d	1523	237	4	25
Obſerv. 1ſt	1500	310	2	20
Interval of time	22	292	2	5
Add the intercalary days for leap years.		5		
Exact interval	22	297	2	5, or 11991005′.

This interval divided by 282, the number of months elapſed in that time, gives 29 days 12 hours 41 minutes for the length of the ſynodical month. But from the obſervations of two other eclipſes, the ſame author more accurately determined the quantity of the ſynodical month to be 29 degrees 11 hours 45 minutes 3 ſeconds: from whence the mean periodical time of the moon comes to be 27 degrees 7 hours 43 minutes 5 ſeconds, which exactly agrees with the obſervations of later aſtronomers.

423 Her diurnal and horary motion.

The quantity of the periodical month being given, by the Rule of Three, we may find the moon's diurnal and horary motion; and thus may tables of the moon's mean motion be conſtructed; and if from the moon's mean diurnal motion that of the ſun be ſubtracted, the remainder will be the moon's mean diurnal motion from the ſun.

424 Her phaſes delineated. Fig. 30. 31.

Having the moon's diſtance from the ſun, her phaſes for that time may be eaſily delineated by the following method laid down by Dr Keil. "Let the circle COBP repreſent the diſk of the moon, which is turned towards the earth; and let OP be the line in which the ſemicircle OMP is projected, which ſuppoſe to be cut by the diameter BC, at right angles; and making LP the radius, take LF equal to the coſine of the elongation of the moon from the ſun: And then upon BC, as the great axis, and LF the leſſer axis, deſcribe the ſemi-ellipſe BFC. This ellipſe will cut off from the diſk of the moon the portion BFCP of the illuminated face, which is viſible to us from the earth."

425 Place of the nodes how found.

Since in the middle of a total eclipſe the moon is exactly in the node, if the ſun's place be found for that time, and ſix ſigns added to it, if the eclipſe is a lunar one the ſun will give the place of the node, or if the eclipſe obſerved is a ſolar one, the place of the node and of the ſun are the ſame. From comparing two eclipſes together, the mean motion of the nodes will thus be found out. The apogee of the moon may be known from her apparent diameter, as already obſerved; and by comparing her place when in the apogee at different times, the motion of the apogee itſelf may alſo be determined.

Theſe ſhort hints will be ſufficient to give a general knowledge of the methods uſed for the ſolution of ſome of the moſt difficult problems in aſtronomy. As for the proper equations to be added or ſubtracted, in order to find out the true motion and place of the moon, together with the particular methods of conſtructing tables for calculating eclipſes, they are given from Mr Ferguſon, in the following ſection.

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SECT. X. *Of Eclipses: With Tables for their Calculation: the Method of constructing them: Rules for Calculation, and Directions for the Delineation of Solar and Lunar Eclipses.*

EVERY planet and ſatellite is illuminated by the ſun; and caſts a ſhadow towards that point of the heavens which is oppoſite to the ſun. This ſhadow is nothing but a privation of light in the ſpace hid from the ſun by the opaque body that intercepts his rays.

426 Eclipſe defined.

When the ſun's light is ſo intercepted by the moon, that to any place of the earth the ſun appears partly or wholly covered, he is ſaid to *undergo an eclipſe*; though, properly ſpeaking, it is only an eclipſe of that part of the earth where the moon's ſhadow or penumbra falls. When the earth comes between the ſun and moon, the moon falls into the earth's ſhadow; and having no light of her own, ſhe ſuffers a real eclipſe from the interception of the ſun's rays. When the ſun is eclipſed to us, the moon's inhabitants, on the ſide next the earth, ſee her ſhadow like a dark ſpot travelling over the earth, about twice as faſt as its equatorial parts move, and the ſame way as they move. When the moon is in an eclipſe, the ſun appears eclipſed to her, total to all thoſe parts on which the earth's ſhadow falls, and of as long continuance as they are in the ſhadow.

427 Figure of the earth ſpherical.

That the earth is ſpherical (for the hills take off no more from the roundneſs of the earth, than grains of duſt do from the roundneſs of a common globe) is evident from the figure of its ſhadow on the moon; which is always bounded by a circular line, although the earth is inceſſantly turning its different ſides to the moon, and very ſeldom ſhows the ſame ſide to her in different eclipſes, becauſe they ſeldom happen at the ſame hours. Were the earth ſhaped like a round flat plate, its ſhadow would only be circular when either of its ſides directly faced the moon, and more or leſs elliptical as the earth happened to be turned more or leſs obliquely towards the moon when ſhe is eclipſed. The moon's

428 Moon's figure the ſame.

different phaſes prove her to be round; for as ſhe keeps ſtill the ſame ſide towards the earth, if that ſide were flat, as it appears to be, ſhe would never be viſible from the third quarter to the firſt; and from the firſt quarter to the third, ſhe would appear as round as when we ſay *ſhe is full*; becauſe, at the end of her firſt quarter, the ſun's light would come as ſuddenly on all her ſide next the earth, as it does on a flat wall, and go off as abruptly at the end of her third quarter.

429 Shadows of the earth and moon conical.

If the earth and ſun were equally large, the earth's ſhadow would be infinitely extended, and all of the ſame bulk; and the planet Mars, in either of its nodes and oppoſite to the ſun, would be eclipſed in the earth's ſhadow. Were the earth larger than the ſun, its ſhadow would increaſe in bulk the farther it extended, and would eclipſe the great planets Jupiter and Saturn, with all their moons, when they were oppoſite to the ſun. But as Mars, in oppoſition, never falls into the earth's ſhadow, altho' he is not then above 42,000,000 miles from the earth, it is plain that the earth is much leſs than the ſun; for otherwiſe its ſhadow could not end in a point at ſo ſmall a diſtance. If the ſun and moon were equally large, the moon's ſhadow would go on to the earth with an equal breadth, and cover a portion of the earth's ſurface more than 2000 miles broad, even if it fell directly againſt the earth's centre, as ſeen from the moon; and much more if it fell obliquely on th earth: But the moon's ſhadow is ſeldom 150 miles broad at the earth, unleſs when it falls very obliquely on the earth, in total eclipſes of the ſun. In annular eclipſes, the moon's real ſhadow ends in a point at ſome diſtance from the earth. The moon's ſmall diſtance from the earth, and the ſhortneſs of her ſhadow, prove her to be leſs than the ſun. And, as the earth's ſhadow is large enough to cover the moon, if her diameter were three times as large as it is (which is evident from her long continuance in the ſhadow when ſhe goes through its centre), it is plain that the earth is much bigger than the moon.

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430 Why there are ſo few eclipſes.

Though all opaque bodies, on which the ſun ſhines, have their ſhadows, yet ſuch is the bulk of the ſun, and the diſtances of the planets, that the primary planets can never eclipſe one another. A primary can eclipſe only its ſecondary, or be eclipſed by it; and never but when in oppoſition or conjunction with the ſun. The primary planets are very ſeldom in theſe poſitions, but the ſun and moon are ſo every month: Whence one may imagine, that theſe two luminaries ſhould be eclipſed every month. But there are few eclipſes in reſpect of the number of new and full moons; the reaſon of which we ſhall now explain.

If the moon's orbit were coincident with the plane of the ecliptic, in which the earth always moves and the ſun appears to move, the moon's ſhadow would fall upon the earth at every change, and eclipſe the ſun to ſome parts of the earth. In like manner, the moon would go through the middle of the earth's ſhadow, and be eclipſed at every full; but with this difference, that ſhe would be totally darkened for above an hour and an half; whereas the ſun never was above four minutes totally eclipſed by the interpoſition of the moon. But one half of the moon's orbit is elevated 5½ degrees above the ecliptic, and the other half as much depreſſed below it; conſequently, the moon's orbit interſects the ecliptic in two oppoſite points called the *moon's nodes*, as has been already taken notice of. When theſe points are in a right line with the centre of the ſun at new or full moon, the ſun, moon, and earth, are all in a right line; and if the moon be then new, her ſhadow falls upon the earth; if full, the earth's ſhadow falls upon her. When the ſun and moon are more than 17 degrees from either of the nodes at the time of conjunction, the moon is then generally too high or too low in her orbit to caſt any part of her ſhadow upon the earth; when the ſun is more than 12 degrees from either of the nodes at the time of full moon, the moon is generally too high or too low in her orbit to go through any part of the earth's ſhadow: and in both theſe caſes there will be no eclipſe. But when the moon is leſs than 17 degrees from either node at the time of conjunction, her ſhadow or penumbra falls more or leſs upon the earth, as ſhe is more or leſs within this limit. And when ſhe is leſs than 12 degrees from either node at the time of oppoſition, ſhe goes through a greater or leſs portion of the earth's ſhadow, as ſhe is more or leſs within this limit. Her orbit contains 360 degrees; of which 17, the limit of ſolar eclipſes on either ſide of the nodes, and 12, the limit of lunar eclipſes, are but ſmall portions: And as the ſun commonly paſſes

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by the nodes but twice in a year, it is no wonder that we have so many new and full moons without eclipses.

To illustrate this (fig. 196.), let ABCD be the ecliptic, RSTU a circle laying in the same plane with the ecliptic, and VXYZ the moon's orbit, all thrown into an oblique view, which gives them an elliptical shape to the eye. One half of the moon's orbit, as VWX, is always below the ecliptic, and the other half XYV above it. The points V and X, where the moon's orbit intersects the circle RSTU, which lies even with the ecliptic, are the moon's nodes; and a right line, as XEV, drawn from one to the other, through the earth's centre, is the line of the nodes, which is carried almost parallel to itself round the sun in a year.

If the moon moved round the earth in the orbit RSTU, which is coincident with the plane of the ecliptic, her shadow would fall upon the earth every time she is in conjunction with the sun, and at every opposition she would go through the earth's shadow. Were this the case, the sun would be eclipsed at every change, and the moon at every full, as already mentioned.

But although the moon's shadow N must fall upon the earth at *a*, when the earth is at E, and the moon in conjunction with the sun at *i*, because she is then very near one of her nodes; and at her opposition *n* she must go through the earth's shadow I, because she is then near the other node; yet, in the time that she goes round the earth to her next change, according to the order of the letters XYVW, the earth advances from E to *e*, according to the order of the letters EFGH; and the line of the nodes VEX, being carried nearly parallel to itself, brings the point *f* of the moon's orbit in conjunction with the sun at that next change: and then the moon being at *f*, is too high above the ecliptic to cast her shadow on the earth: and as the earth is still moving forward, the moon at her next opposition will be at *g*, too far below the ecliptic to go through any part of the earth's shadow; for by that time the point *g* will be at a considerable distance from the earth as seen from the sun.

When the earth comes to F, the moon in conjunction with the sun Z is not at *k* in a plane coincident with the ecliptic, but above it at Y in the highest part of her orbit; and then the point *b* of her shadow O goes far above the earth (as in fig. 2. which is an edge view of fig. 1.). The moon at her next opposition, is not at *o* (fig. 1.), but at W, where the earth's shadow goes far above her (as in fig. 2.). In both these cases the line of the nodes VEX (fig. 1) is about ninety degrees from the sun, and both luminaries are as far as possible from the limits of the eclipses.

When the earth has gone half round the ecliptic from E to G, the line of the nodes VGX is nearly, if not exactly, directed towards the sun at Z; and then the new moon *l* casts her shadow P on the earth G; and the full moon *p* goes through the earth's shadow L; which brings on eclipses again, as when the earth was at E.

When the earth comes to H, the new moon falls not at *m* in a plane coincident with the ecliptic CD, but at W in her orbit below it; and then her shadow Q (see fig. 197.) goes far below the earth. At the next full she is not at *q* (fig. 196.), but at Y in her orbit 5½ degrees above *q*, and at her greatest height above the ecliptic CD; being then as far as possible, at any opposition, from the earth's shadow M, as in fig. 197.

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So, when the earth is at E and G, the moon is about her nodes at new and full, and in her greatest north and south declination (or latitude as it is generally called) from the ecliptic at her quarters; but when the earth is at F or H, the moon is in her greatest north and south declination from the ecliptic at new and full, and in the nodes about her quarters.

The point X, where the moon's orbit crosses the ecliptic, is called the *ascending node*, because the moon ascends from it above the ecliptic; and the opposite point of intersection V called the *descending node*, because the moon descends from it below the ecliptic. When the moon is at Y in the highest point of her orbit, she is in her greatest north latitude; and when she is at W in the lowest point of her orbit, she is in her greatest south latitude.

431 Appearance of eclipses determined from the motion of the nodes.

If the line of the nodes, like the earth's axis, was carried parallel to itself round the sun, there would be just half a year between the conjunctions of the sun and nodes. But the nodes shift backwards, or contrary to the earth's annual motion, 19½ deg. every year; and therefore the same node comes round the sun 19 days sooner every year than on the year before. Consequently, from the time that the ascending node X (when the earth is at E) passes by the sun as seen from the earth, it is only 173 days (not half a year) till the descending node V passes by him. Therefore in whatever time of the year we have eclipses of the luminaries about either node, we may be sure that in 173 days afterward we shall have eclipses about the other node. And when at any time of the year the line of the nodes is in the situation VGX, at the same time next year it will be in the situation *r*G*s*; the ascending node having gone backward, that is, contrary to the order of signs, from X to *s*, and the descending node from V to *r*; each 19½ deg. At this rate, the nodes shift through all the signs and degrees of the ecliptic in 18 years and 225 days; in which time there would always be a regular period of eclipses, if any complete number of lunations were finished without a fraction. But this never happens; for if both the sun and moon should start from a line of conjunction with either of the nodes in any point of the ecliptic, the sun would perform 18 annual revolutions and 222 degrees over and above, and the moon 230 lunations and 85 degrees of the 231st, by the time the node came round to the same point of the ecliptic again; so that the sun would then be 138 degrees from the node, and the moon 85 degrees from the sun.

But, in 223 mean lunations, after the sun, moon, and nodes, have been once in a line of conjunction, they return so nearly to the same state again, as that the same node, which was in conjunction with the sun and moon at the beginning of the first of these lunations, will be within 28′ 12″ of a degree of a line of conjunction with the sun and moon again, when the last of these lunations is completed. And therefore in that time there will be a regular period of eclipses, or return of the same eclipse, for many ages——In this period (which was first discovered by the Chaldeans) there are 18 Julian years 11 days 7 hours 43 minutes 20 seconds, when the last day of February in leap-years is four times included; but when it is five times included,

Fig. 190

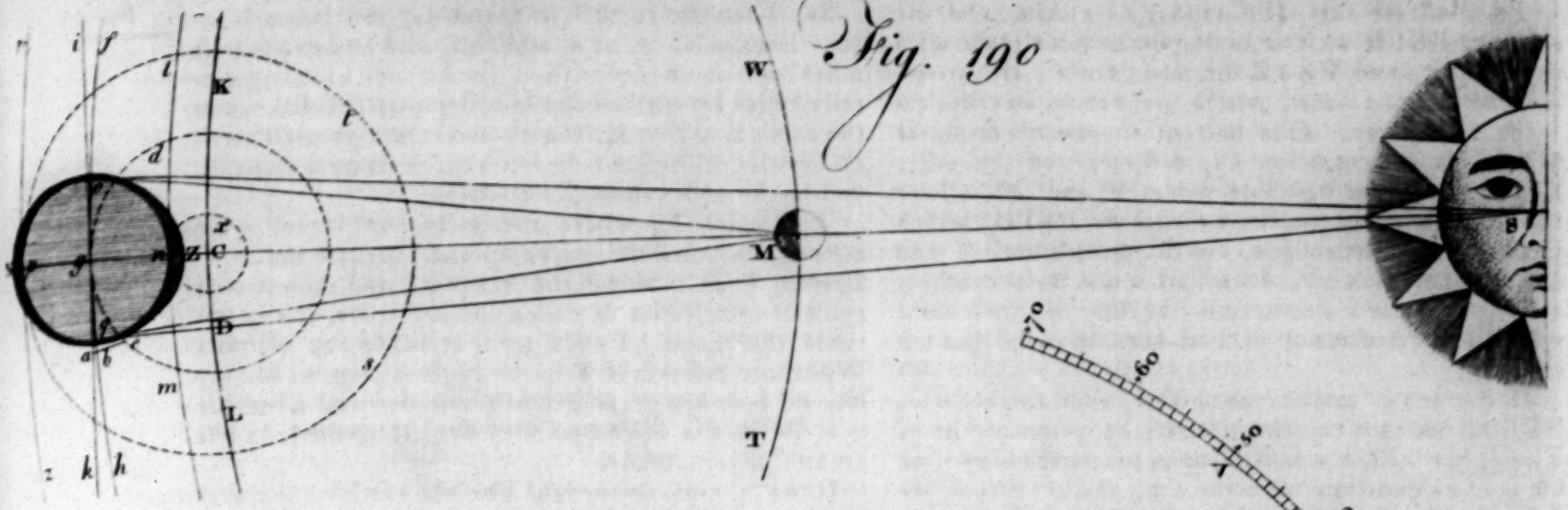


Fig. 191

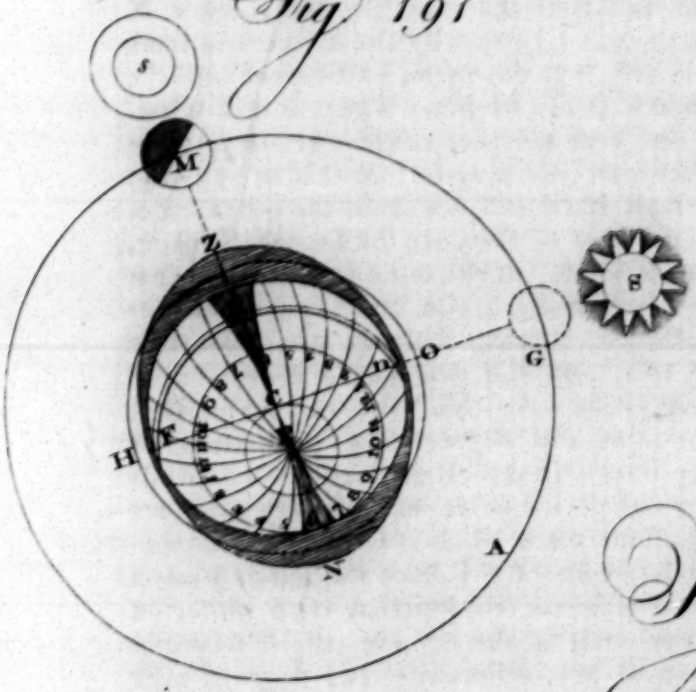


Fig. 195

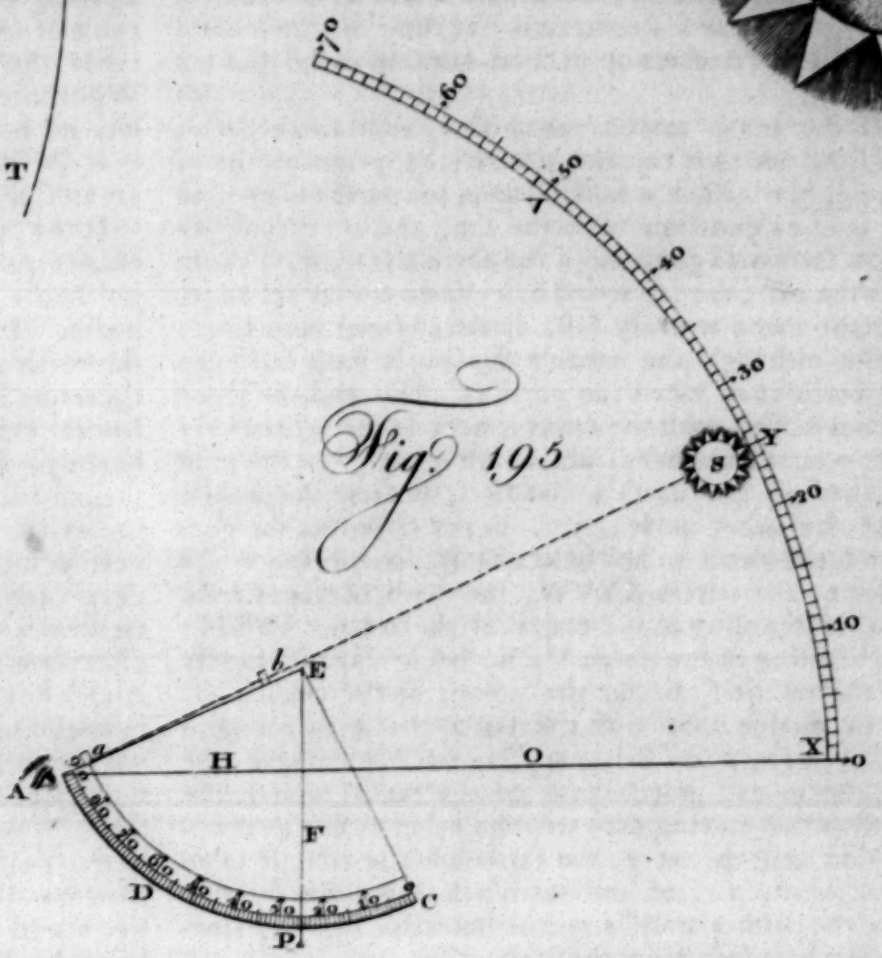


Fig. 192

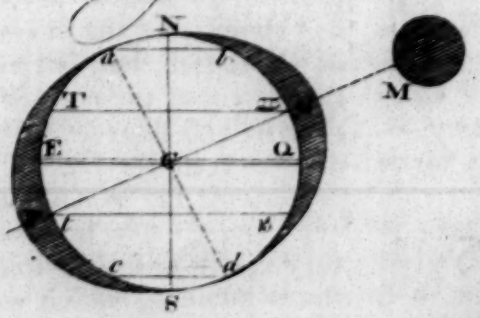


Fig. 193

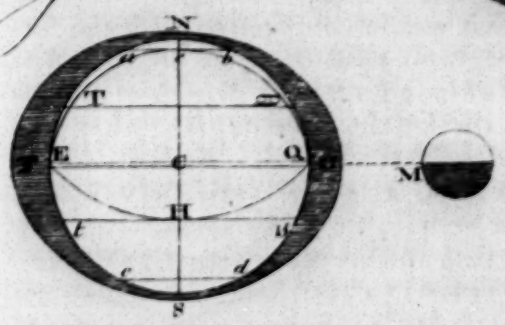
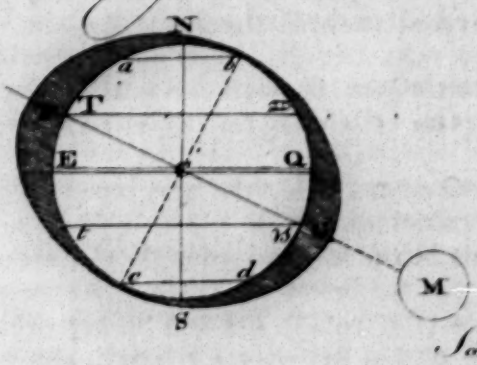


Fig. 194



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ded, the period consists of only 18 years 10 days 7 hours 43 minutes 20 seconds. Consequently, if to the mean time of any eclipse, either of the sun or moon, you add 18 Julian years 11 days 7 hours 43 minutes 20 seconds, when the last day of February in leap-years comes in four times, or a day less when it comes in five times, you will have the mean time of the return of the same eclipse.

432 When the same eclipse returns again.

But the falling back of the line of conjunctions or oppositions of the sun and moon 28′ 12″ with respect to the line of the nodes in every period, will wear it out in process of time; and after that, it will not return again in less than 12,492 years.—These eclipses of the sun, which happen about the ascending node, and begin to come in at the north pole of the earth, will go a little southerly at each return, till they go quite off the earth at the south pole; and those which happen about the descending node, and begin to come in at the south pole of the earth, will go a little northerly at each return, till at last they quite leave the earth at the north pole.

433 History of the solar eclipse in 1764.

To exemplify this matter, we shall first consider the sun's eclipse (March 21st old style, April 1st new style), A. D. 1764, according to its mean revolutions, without equating the times, or the sun's distance from the node; and then according to its true equated times.

This eclipse fell in open space at each return, quite clear of the earth, ever since the creation, till A. D. 1295, June 13th old style, at 12h. 52m. 59 sec. *post meridiem*, when the moon's shadow first touched the earth at the north pole; the sun being then 17° 48′ 27″ from the ascending node. In each period since that time, the sun has come 28′ 12″ nearer and nearer the same node, and the moon's shadow has therefore gone more and more southerly.—In the year 1962, July 18th old style, at 19 h. 36 m. 21 sec. *p. m.* when the same eclipse will have returned 38 times, the sun will be only 24′ 45″ from the ascending node, and the centre of the moon's shadow will fall a little northward of the earth's centre.—At the end of the next following period, A. D. 1980, July 28th old style, at 18 h. 19 m. 41 sec. *p. m.* the sun will have receded back 3′ 27″ from the ascending node, and the moon will have a very small degree of southern latitude, which will cause the centre of her shadow to pass a very small matter south of the earth's centre.—After which, in every following period, the sun will be 28′ 12″ farther back from the ascending node than in the period last before; and the moon's shadow will go still farther and farther southward, until September 12th old style, at 23 h. 46 m. 22 sec. *p. m.* A. D. 2665; when the eclipse will have completed its 77th periodical return, and will go quite off the earth at the south pole (the sun being then 17° 55′ 22″ back from the node), and cannot come in at the north pole, so as to begin the same course over again, in less than 12,492 years afterwads.—And such will be the case of every other eclipse of the sun: For, as there is about 18 degrees on each side of the node within which there is a possibility of eclipses, their whole revolution goes through 36 degrees about that node, which, taken from 360 degrees, leaves remaining 324 degrees for the eclipses to travel *in expansum*. And as this 36 degrees is not gone through in less than 77 periods, which takes up 1388 years, the remaining 324 degrees cannot be so gone through in less than 12,492 years. For, as 36 is to 1388, so is 324 to 12,492.

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To illustrate this a little farther, we shall examine some of the most remarkable circumstances of the returns of the eclipse which happened July 14th 1748, about noon. This eclipse, after traversing the voids of space from the creation, at last began to enter the Terra Australis Incognita about 88 years after the conquest, which was the last of king Stephen's reign: every Chaldean period it has crept more northerly, but was still invisible in Britain before the year 1622; when, on the 30th of April, it began to touch the south parts of England about two in the afternoon; its central appearance rising in the American south seas, and traversing Peru and the Amazon's country, through the Atlantic ocean into Africa, and setting in the Æthiopian continent, not far from the beginning of the Red sea.

434 Of the eclipse in 1748.

Its next visible period was, after three Chaldean revolutions, in 1676, on the first of June, rising central in the Atlantic ocean, passing us about nine in the morning, with four digits eclipsed on the under limb, and setting in the gulph of Cochinchina in the East Indies.

It being now near the solstice, this eclipse was visible the very next return in 1694, in the evening; and in two periods more, which was in 1730, on the 4th of July, was seen about half eclipsed just after sun-rise, and observed both at Wirtemberg in Germany, and Pekin in China, soon after which it went off.

Eighteen years more afforded us the eclipse which fell on the 14th of July 1748.

The next visible return happened on July 25th 1766 in the evening, about four digits eclipsed; and, after two periods more, will happen on August 16th 1802, early in the morning, about five digits, the centre coming from the north frozen continent, by the capes of Norway, through Tartary, China, and Japan, to the Ladrone islands, where it goes off.

Again, in 1820, August 26th, between one and two, there will be another great eclipse at London, about 10 digits; but, happening so near the equinox, the centre will leave every part of Britain to the west, and enter Germany at Embden, passing by Venice, Naples, Grand Cairo, and set in the gulf of Bassora near that city.

It will be no more visible till 1874, when five digits will be obscured (the centre being now about to leave the earth) on September 28th. In 1892, the sun will go down eclipsed in London: and again, in 1928, the passage of the centre will be in the *expansum*, though there will be two digits eclipsed at London, October the 31st of that year, and about the year 2090 the whole penumbra will be wore off; whence no more returns of this eclipse can happen till after a revolution of 10,000 years.

435 Period in which the phenomena of an eclipse are completed.

From these remarks on the entire revolution of this eclipse, we may gather, that a thousand years more or less (for there are some irregularities that may protract or lengthen this period 100 years), complete the whole terrestrial phenomena of any single eclipse: and since 20 periods of 54 years each, and about 33 days, comprehend the entire extent of their revolution, is is evident, that the times of the returns will pass through a circuit of one year and ten months, every Chaldean period being

being 10 or 11 days later, and of the equable appearances, about 32 or 33 days. Thus, though this eclipſe happens about the middle of July, no other ſubſequent eclipſe of this period will return till the middle of the ſame month again; but wear conſtantly each period 10 or 11 days forward, and at laſt appear in winter, but then it begins to ceaſe from affecting us.

436 Seldom more than two great eclipſes in this period.

Another concluſion from this revolution may be drawn, that there will ſeldom be any more than two great eclipſes of the ſun in the interval of this period, and theſe follow ſometimes next return, and often at greater diſtances. That of 1715 returned again in 1733 very great; but this preſent eclipſe will not be great till the arrival of 1820, which is a revolution of four Chaldean periods: ſo that the irregularities of their circuits muſt undergo new computations to aſſign them exactly.

437 Eclipſes come in by the north and ſouth poles.

Nor do all eclipſes come in at the ſouth pole: that depends altogether on the poſition of the lunar nodes, which will bring in as many from the expanſum one way as the other; and ſuch eclipſes will wear more ſoutherly by degrees, contrary to what happens in the preſent caſe.

The eclipſe, for example, of 1736 in September, had its centre in the expanſum, and ſet about the middle of its obſcurity in Britain; it will wear in at the north pole, and in the year 2600, or thereabouts, go off into the expanſum on the ſouth ſide of the earth.

The eclipſes therefore which happened about the creation are little more than half way yet of their etherial circuit; and will be 4000 years before they enter the earth any more. This grand revolution ſeems to have been entirely unknown to the ancients.

438 Very ancient eclipſes cannot be calculated by our tables.

It is particularly to be noted, that eclipſes which have happened many centuries ago will not be found by our preſent tables to agree exactly with ancient obſervations, by reaſon of the great anomalies in the lunar motions; which appears an inconteſtable demonſtration of the non-eternity of the univerſe. For it ſeems confirmed by undeniable proofs, that the moon now finiſhes her period in leſs time than formerly, and will continue, by the centripetal law, to approach nearer and nearer the earth, and to go ſooner and ſooner round it: nor will the centrifugal power be ſufficient to compenſate the different gravitations of ſuch an aſſemblage of bodies as conſtitute the ſolar ſyſtem, which would come to ruin of itſelf, without ſome regulation and adjuſtment of their original motions.

We are credibly informed from the teſtimony of the ancients, that there was a total eclipſe of the ſun predicted by Thales to happen in the fourth year of the 48th Olympiad, either at Sardis or Miletus in Aſia, where Thales then reſided. That year correſponds to the 585th year before Chriſt; when accordingly there happened a very ſignal eclipſe of the ſun, on the 28th of May, anſwering to the preſent 10th of that month, central through North America, the ſouth parts of France, Italy, &c. as far as Athens, or the iſles in the Ægean ſea; which is the fartheſt that even the Caroline tables carry it; and conſequently make it inviſible to any part of Aſia, in the total character; though there are good reaſons to believe that it extended to Babylon, and went down central over that city. We are not however to imagine, that it was ſet before it paſſed Sardis and the Aſiatic towns, where the predictor lived; becauſe an inviſible eclipſe could have been of no ſervice to demonſtrate his ability in aſtronomical ſciences to his countrymen, as it could give no proof of its reality.

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For a further illuſtration, Thucydides relates, That a ſolar eclipſe happened on a ſummer's day, in the afternoon, in the firſt year of the Peloponneſian war, ſo great, that the ſtars appeared. Rhodius was victor in the Olympic games the fourth year of the ſaid war, being alſo the fourth year of the 87th Olympiad, on the 428th year before Chriſt. So that the eclipſe muſt have happened in the 431ſt year before Chriſt; and by computation it appears, that on the third of Auguſt there was a ſignal eclipſe which would have paſſed over Athens, central about ſix in the evening, but which our preſent tables bring no farther than the ancient Syrtes on the African coaſt, above 400 miles from Athens; which, ſuffering in that caſe but nine digits, could by no means exhibit the remarkable darkneſs recited by this hiſtorian: the centre therefore ſeems to have paſſed Athens about ſix in the evening, and probably might go down about Jeruſalem, or near it, contrary to the conſtruction of the preſent tables. Theſe things are only mentioned by way of caution to the preſent aſtronomers, in recomputing ancient eclipſes; and they may examine the eclipſe of Nicias, ſo fatal to the Athenian fleet; that which overthrew the Macedonian army, &c.

439 Number of eclipſes in a year.

In any year, the number of eclipſes of both luminaries cannot be leſs than two, nor more than ſeven; the moſt uſual number is four, and it is very rare to have more than ſix. For the ſun paſſes by both the nodes but once a-year, unleſs he paſſes by one of them in the beginning of the year; and if he does, he will paſs by the ſame node again a little before the year be finiſhed; becauſe, as theſe points move 19½ degrees backwards every year, the ſun will come to either of them 173 days after the other. And when either node is within 17 degrees of the ſun at the time of new moon, the ſun will be eclipſed. At the ſubſequent oppoſition, the moon will be eclipſed in the other node, and come round to the next conjunction again ere the former node be 17 degrees paſt the ſun, and will therefore eclipſe him again. When three eclipſes fall about either node, the like number generally falls about the oppoſite; as the ſun comes to it in 173 days afterward; and ſix lunations contain but four days more. Thus, there may be two eclipſes of the ſun and one of the moon about each of her nodes. But when the moon changes in either of the nodes, ſhe cannot be near enough the other node at the next full to be eclipſed; and in ſix lunar months afterwards ſhe will change near the other node: in theſe caſes, there can be but two eclipſes in a year, and they are both of the ſun.

A longer period than the abovementioned, for comparing and examining eclipſes which happen at long intervals of time, is 557 years, 21 days, 18 hours, 30 minutes, 11 ſeconds; in which time there are 6890 mean lunations; and the ſun and node meet again ſo nearly as to be but 11 ſeconds diſtant; but then it is not the ſame eclipſe that returns, as in the ſhorter period abovementioned.

Eclipſes

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Eclipses of the sun are more frequent than of the moon, because the sun's ecliptic limits are greater than the moon's; yet we have more visible eclipses of the moon than of the sun, because eclipses of the moon are seen from all parts of that hemisphere of the earth which is next her, and are equally great to each of those parts; but the sun's eclipses are visible only to that small portion of the hemisphere next him whereon the moon's shadow falls.

440 Why more eclipses of the moon than of the sun are observed.

The moon's orbit being elliptical, and the earth in one of its focuses, she is once at her least distance from the earth, and once at her greatest, in every lunation. When the moon changes at her least distance from the earth, and so near the node that her dark shadow falls upon the earth, she appears big enough to cover the whole disk of the sun from that part on which her shadow falls; and the sun appears totally eclipsed there for some minutes: but when the moon changes at her greatest distance from the earth, and so near the node that her dark shadow is directed towards the earth, her diameter subtends a less angle than the sun's; and therefore she cannot hide his whole disk from any part of the earth, nor does her shadow reach it at that time; and to the place over which the point of her shadow hangs, the eclipse is annular, the sun's edge appearing like a luminous ring all around the body of the moon.

441 Total and annular eclipses.

When the change happens within 17 degrees of the node, and the moon at her mean distance from the earth, the point of her shadow just touches the earth, and she eclipseth the sun totally to that small spot whereon her shadow falls; but the darkness is not of a moment's continuance.

The moon's apparent diameter, when largest, exceeds the sun's, when least, only 1 minute 38 seconds of a degree; and in the greatest eclipse of the sun that can happen at any time and place, the total darkness continues no longer than whilst the moon is going 1 minute 38 seconds from the sun in her orbit, which is about 3 minutes and 13 seconds of an hour.

442 Extent of the moon's shadow and penumbra.

The moon's dark shadow covers only a spot on the earth's surface about 180 English miles broad, when the moon's diameter appears largest, and the sun's least; and the total darkness can extend no farther than the dark shadow covers. Yet the moon's partial shadow or penumbra may then cover a circular space 4900 miles in diameter, within all which the sun is more or less eclipsed, as the places are less or more distant from the centre of the penumbra. When the moon changes exactly in the node, the penumbra is circular on the earth at the middle of the general eclipse; because at that time it falls perpendicularly on the earth's surface; but at every other moment it falls obliquely, and will therefore be elliptical: and the more so, as the time is longer before or after the middle of the general eclipse; and then much greater portions of the earth's surface are involved in the penumbra.

443 Beginning, ending, &c. of a solar eclipse.

When the penumbra first touches the earth, the general eclipse begins; when it leaves the earth, the general eclipse ends: from the beginning to the end the sun appears eclipsed in some part of the earth or other. When the penumbra touches any place, the eclipse begins at that place, and ends when the penumbra leaves it. When the moon changes in the node, the penumbra goes over the centre of the earth's disk as seen from the moon; and consequently by describing the longest line possibly on the earth, continues the longest upon it; namely, at a mean rate, 5 hours 50 minutes; more, if the moon be at her greatest distance from the earth, because she then moves slowest; less, if she be at her least distance, because of her quicker motion.

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To make several of the above and other phenomena plainer, let S be the sun, E the earth, M the moon, and AMP the moon's orbit. Draw the right line W *e* from the western side of the sun at W, touching the western side of the moon at *c*, and the earth at *e*: draw also the right line V *d* from the eastern side of the sun at V, touching the eastern side of the moon at *d*, and the earth at *e*: the dark space *c e d* included between those lines is the moon's shadow, ending in a point at *e*, where it touches the earth; because in this case the moon is supposed to change at M in the middle between A the apogee, or farthest point of her orbit from the earth, and P the perigee, or nearest point to it. For, had the point P been at M, the moon had been nearer the earth; and her dark shadow at *e* would have covered a space upon it about 180 miles broad, and the sun would have been totally darkened, with some continuance: but had the point A been at M, the moon would have been farther from the earth, and her shadow would have ended in a point a little above *e*, and therefore the sun would have appeared like a luminous ring all around the moon. Draw the right lines WX *d h* and VX *c g*, touching the contrary sides of the sun and moon, and ending on the earth at *a* and *b*: draw also the right line SXM, from the centre of the sun's disk, through the moon's centre, to the earth; and suppose the two former lines WX*dh* and VX*cg* to revolve on the line SXM as an axis, and their points *a* and *b* will describe the limits of the penumbra TT on the earth's surface, including the large space *a b a*; within which the sun appears more or less eclipsed, as the places are more or less distant from the verge of the penumbra *a b*.

Fig. 198.

Draw the right line *y* 12 across the sun's disk, perpendicular to SXM the axis of the penumbra: then divide the line *y* 12 into 12 equal parts, as in the figure, for the twelve digits or equal parts of the sun's diameter; and, at equal distances from the centre of the penumbra at *e* (on the earth's surface at YY) to its edge *a b*, draw twelve concentric circles, marked with the numeral figures 1 2 3 4, &c. and remember that the moon's motion in her orbit AMP is from west to east, as from *s* to *t*. Then,

To an observer on the earth at *b*, the eastern limb of the moon at *d* seems to touch the western limb of the sun at W, when the moon is at M; and the sun's eclipse begins at *b*, appearing as at A, fig. 203. at the left hand; but at the same moment of absolute time, to an observer at *a* in fig. 198. the western edge of the moon at *c* leaves the eastern edge of the sun at V, and the eclipse ends, as at the right hand C fig. 203. At the very same instant, to all those who live on the circle marked 1 on the earth E, in fig. 198. the moon M cuts off or darkens a twelfth part of the sun S, and eclipses him one digit, and at 1 in fig. 203.: to those who live on the circle marked 2 in fig. 198. the moon cuts off two-twelfth parts of the sun, as at 2 in fig. 203.: to those on the circle 3, three parts; and so

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on to the centre at 12 in fig. 198. where the ſun is centrally eclipſed, as at B in the middle of fig. 203.; under which figure there is a ſcale of hours and minutes, to ſhow at a mean ſtate how long it is from the beginning to the end of a central eclipſe of the ſun on the parallel of London; and how many digits are eclipſed at any particular time from the beginning at A to the middle at B, or the end at C. Thus, in 16 minutes from the beginning, the ſun is two digits eclipſed; in an hour and five minutes, eight digits; and in an hour and 37 minutes, 12 digits.

By fig. 198. it is plain, that the ſun is totally or centrally eclipſed but to a ſmall part of the earth at any time, becauſe the dark conical ſhadow *e* of the moon M falls but on a ſmall part of the earth; and that the partial eclipſe is confined at that time to the ſpace included by the circle *a b*, of which only one half can be projected in the figure, the other half being ſuppoſed to be hid by the convexity of the earth *E*: and likewiſe that no part of the ſun is eclipſed to the large ſpace YY of the earth, becauſe the moon is not between the ſun and any of that part of the earth; and therefore to all that part of the eclipſe is inviſible. The earth turns eaſtward on its axis, as from *g* to *h*, which is the ſame way that the moon's ſhadow moves; but the moon's motion is much ſwifter in her orbit from *s* to *t*: and therefore, although eclipſes of the ſun are of longer duration on account of the earth's motion on its axis than they would be if that motion was ſtopped, yet, in four minutes of time at moſt, the moon's ſwifter motion carries her dark ſhadow quite over any place that its centre touches at the time of greateſt obſcuration. The motion of the ſhadow on the earth's diſk is equal to the moon's motion from the ſun, which is about 30½ minutes of a degree every hour at a mean rate; but ſo much of the moon's orbit is equal to 30½ degrees of a great circle on the earth; and therefore the moon's ſhadow goes 30½ degrees, or 1830 geographical miles, on the earth in an hour, or 30½ miles in a minute, which is almoſt four times as ſwift as the motion of a cannon-ball.

As ſeen from the ſun or moon, the earth's axis appears differently inclined every day of the year, on account of keeeping its parallelism throughout its annual courſe. In fig. 205. let EDON be the earth at the two equinoxes and the two ſolſtices, NS its axis, N the north pole, S the ſouth pole, ÆQ the equator, T the tropic of Cancer, *t* the tropic of Capricorn, and ABC the circumference of the earth's enlightened diſk as ſeen from the ſun or new moon at theſe times. The earth's axis has the poſition NES at the vernal equinox, lying towards the right hand, as ſeen from the ſun or new moon; its poles N and S being then in the circumference of the diſk; and the equator and all its parallels ſeen to be ſtraight lines, becauſe their planes paſs through the obſerver's eye looking down upon the earth from the ſun or moon directly over E, where the ecliptic FG interſects the equator Æ. At the ſummer ſolſtice, the earth's axis has the poſition NDS; and that part of the ecliptic FG, in which the moon is then new, touches the tropic of Cancer T at D. The north pole at that time inclining 23½ degrees towards the ſun, falls ſo many degrees within the earth's enlightened diſk, becauſe the ſun is then vertical to D 23½ degrees north of the equator ÆQ; and the equator with all its parallels ſeem elliptic curves bending downward, or towards the ſouth pole, as ſeen from the ſun; which pole, together with 23½ degrees all round it, is hid behind the diſk in the dark hemiſphere of the earth. At the autumnal equinox, the earth's axis has the poſition NOS, lying to the left hand as ſeen from the ſun or new moon, which are then vertical to O, where the ecliptic cuts the equator ÆQ. Both poles now lie in the circumference of the diſk, the north pole juſt going to diſappear behind it, and the ſouth pole juſt entering into it; and the equator, with all its parallels, ſeem to be ſtraight lines, becauſe their planes paſs through the obſerver's eye, as ſeen from the ſun, and very nearly ſo as ſeen from the moon. At the winter ſolſtice, the earth's axis has the poſition NNS, when its ſouth pole S inclining 23½ degrees towards the ſun, falls 23½ degrees within the enlightened diſk, as ſeen from the ſun or new moon, which are then vertical to the tropic of Capricorn *t*, 23½ degrees ſouth of the equator ÆQ; and the equator, with all its parallels, ſeem elliptic curves bending upward; the north pole being as far behind the diſk in the dark hemiſphere as the ſouth pole is come into the light. The nearer that at any time of the year is to the equinoxes or ſolſtices, the more it partakes of the phenomena relating to them.

Thus it appears, that from the vernal equinox to the autumnal, the north pole is enlightened; and the equator and all its parallels appear elliptical as ſeen from the ſun, more or leſs curved as the time is nearer to, or farther from, the ſummer ſolſtice; and bending downwards, or towards the ſouth pole; the reverſe of which happens from the autumnal equinox to the vernal. A little conſideration will be ſufficient to convince the reader, that the earth's axis inclines towards the ſun at the ſummer ſolſtice; from the ſun at the winter ſolſtice: and ſidewiſe to the ſun at the equinoxes; but towards the right hand, as ſeen from the ſun at the vernal equinox; and towards the left hand at the autumnal. From the winter to the ſummer ſolſtice, the earth's axis inclines more or leſs to the right hand, as ſeen from the ſun; and the contrary from the ſummer to the winter ſolſtice.

444 Eclipſes affected by the poſition of the earth's axis.

The different poſitions of the earth's axis, as ſeen from the ſun at different times of the year, affect ſolar eclipſes greatly with regard to particular places; yea, ſo far as would make central eclipſes which fall at one time of the year inviſible if they fell at another, even though the moon ſhould always change in the nodes, and at the ſame hour of the day; of which indefinitely various affections, we ſhall only give examples for the times of the equinoxes and ſolſtices.

In the ſame diagram, let FG be part of the ecliptic, and IK, *i k*, *i k*, *i k*, part of the moon's orbit; both ſeen edgewiſe, and therefore projected into right lines; and let the interſections NODE be one and the ſame node at the above times, when the earth has the forementioned different poſitions; and let the ſpaces included by the circles P *p p p* be the penumbra at theſe times, as its centre is paſſing over the centre of the earth's diſk. At the winter ſolſtice, when the earth's axis has the poſition NNS, the centre of the penumbra P touches the tropic of Capricorn *t* in N at the middle of the general eclipſe; but no part of the penumbra touches the tropic of Cancer T. At the ſum

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summer ſolſtice, when the earth's axis has the poſition NDS (*i D k* being then part of the moon's orbit whoſe node is at D), the penumbra *p* has its centre at D, on the tropic of Cancer T, at the middle of the general eclipſe, and then no part of it touches the tropic of Capricorn *t*. At the autumnal equinox, the earth's axis has the poſition NOS (*i O k* being then part of the moon's orbit), and the penumbra equally includes part of both tropics T and *t* at the middle of the general eclipſe: at the vernal equinox it does the ſame, becauſe the earth's axis has the poſition NES; but, in the former of theſe two laſt caſes, the penumbra enters the earth at A, north of the tropic of Cancer T, and leaves it at *m*, ſouth of the tropic of Capricorn *t*; having gone over the earth obliquely ſouthward, as its centre deſcribed the line AO*m*: whereas, in the latter caſe, the penumbra touches the earth at *n*, ſouth of the equator ÆQ, and deſcribing the line *n*Eq (ſimilar to the former line AO*m* in open ſpace), goes obliquely northward over the earth, and leaves it at *q*, north of the equator.

In all theſe circumſtances the moon has been ſuppoſed to change at noon in her deſcending node: Had ſhe changed in her aſcending node, the phenomena would have been as various the contrary way, with reſpect to the penumbra's going northward or ſouthward over the earth. But becauſe the moon changes at all hours, as often in one node as in the other, and at all diſtances from them both at different times as it happens, the variety of the phaſes of eclipſes are almoſt innumerable, even at the ſame places; conſidering alſo how variouſly the ſame places are ſituated on the enlightened diſk of the earth, with reſpect to the penumbra's motion, at the different hours when eclipſes happen.

When the moon changes 17 degrees ſhort of her deſcending node, the penumbra P 18 juſt touches the northern part of the earth's diſk, near the north pole N; and as ſeen from that place, the moon appears to touch the ſun, but hides no part of him from ſight. Had the change been as far ſhort of the aſcending node, the penumbra would have touched the ſouthern part of the diſk near the ſouth pole S. When the moon changes 12 degrees ſhort of the deſcending node, more than a third part of the penumbra P12 falls on the northern part of the earth at the middle of the general eclipſe: Had ſhe changed as far paſt the ſame node, as much of the other ſide of the penumbra about P would have fallen on the ſouthern part of the earth; all the reſt in the expanſum, or open ſpace. When the moon changes 6 degrees from the node, almoſt the whole penumbra P6 falls on the earth at the middle of the general eclipſe. And laſtly, when the moon changes in the node at N, the penumbra PN takes the longeſt courſe poſſible on the earth's diſk; its centre falling on the middle thereof, at the middle of the general eclipſe. The farther the moon changes from either node, within 17 degrees of it, the ſhorter is the penumbra's continuance on the earth, becauſe it goes over a leſs portion of the diſk, as is evident by the figure.

445 Duration of eclipſes in different parts of the earth.

The nearer that the penumbra's centre is to the equator at the middle of the general eclipſe, the longer is the duration of the eclipſe at all thoſe places where it is central; becauſe, the nearer that any place is to the equator, the greater is the circle it deſcribes by the earth's motion on its axis: and ſo the place moving quicker, keeps longer in the penumbra, whoſe motion is the ſame way with that of the place, though faſter, as has been already mentioned. Thus (ſee the earth at D, and the penumbra at 12) whilſt the point *b* in the polar circle *a b c d* is carried from *b* to *c* by the earth's diurnal motion, the point *d* on the tropic of Cancer T is carried a much greater length from *d* to D; and therefore, if the penumbra's centre goes one time over *c* and another time over D, the penumbra will be longer in paſſing over the moving place *d* than it was in paſſing over the moving place *b*. Conſequently, central eclipſes about the poles are of the ſhorteſt duration; and about the equator, of the longeſt.

In the middle of ſummer, the whole frigid zone, included by the polar circle *a b c d*, is enlightened; and if it then happens that the penumbra's centre goes over the north pole, the ſun will be eclipſed much the ſame number of digits at *a* as at *c*; but whilſt the penumbra moves eaſtward over *c*, it moves eaſtward over *a*; becauſe, with reſpect to the penumbra, the motions of *a* and *c* are contrary: for *c* moves the ſame way with the penumbra towards *d*, but *a* moves the contrary way towards *b*; and therefore the eclipſe will be of longer duration at *c* than at *a*. At *a* the eclipſe begins on the ſun's eaſtern limb, but at *c* on his weſtern: at all places lying without the polar circles, the ſun's eclipſes begin on his weſtern limb, or near it, and end on or near his eaſtern. At thoſe places where the penumbra touches the earth, the eclipſe begins with the riſing ſun, on the top of his weſtern or uppermoſt edge; and at thoſe places where the penumbra leaves the earth, the eclipſe ends with the ſetting ſun, on the top of his eaſtern edge, which is then uppermoſt, juſt at its diſappearing in the horizon.

If the moon were ſurrounded by an atmoſphere of any conſiderable denſity, it would ſeem to touch the ſun a little before the moon made her appulſe to his edge, and we ſhould ſee a little faintneſs on that edge before it were eclipſed by the moon: but as no ſuch faintneſs has been obſerved, it ſeems plain, that the moon has no ſuch atmoſphere as that of the earth. The faint ring of light ſurrounding the ſun in total eclipſes, called by Caſſini *la chevelure du ſoliel*, is ſaid to be the atmoſphere of the ſun; becauſe it has been obſerved to move equally with the ſun, not with the moon. See n° 147.

446 Lunar eclipſes explained.

Having been ſo prolix concerning eclipſes of the ſun, we ſhall drop that ſubject at preſent, and proceed to the doctrine of lunar eclipſes; which, being more ſimple, may be explained in leſs time.

That the moon can never be eclipſed but at the time of her being full, and the reaſon why ſhe is not eclipſed at every full, has been ſhown already. In fig. 198. let S be the ſun, E the earth, RR the earth's ſhadow, and B the moon in oppoſition to the ſun: In this ſituation the earth intercepts the ſun's light in its way to the moon; and when the moon touches the earth's ſhadow at *v*, ſhe begins to be eclipſed on her eaſtern limb *x*, and continues eclipſed until her weſtern limb *y* leaves the ſhadow at *w*: At B ſhe is in the middle of the ſhadow, and conſequently in the middle of the eclipſe.

The moon, when totally eclipſed, is not inviſible if ſhe

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447 Why the moon is visible when eclipsed.

she be above the horizon and the sky be clear; but appears generally of a dusky colour, like tarnished copper, which some have thought to be the moon's native light. But the true cause of her being visible is the scattered beams of the sun, bent into the earth's shadow by going through the atmosphere; which, being more or less dense near the earth than at considerable heights above it, refracts or bends the sun's rays more inward, the nearer they are passing by the earth's surface, than those rays which go through higher parts of the atmosphere, where it is less dense according to its height, until it be so thin or rare as to lose its refractive power. Let the circle *f g h i*, concentric to the earth, include the atmosphere whose refractive power vanishes at the heights *f* and *i*; so that the rays W*fw* and V*iv* go on straight without suffering the least refraction: but all those rays which enter the atmosphere between *f* and *k*, and between *i* and *l*, on opposite sides of the earth, are gradually more bent inward as they go thro' a greater portion of the atmosphere, until the rays W*k* and V*l* touching the earth at *m* and *n*, are bent so much as to meet at *q*, a little short of the moon; and therefore the dark shadow of the earth is contained in the space *m o q p n*, where none of the sun's rays can enter; all the rest RR, being mixed by the scattered rays which are refracted as above, is in some measure enlightened by them; and some of those rays falling on the moon, give her the colour of tarnished copper, or of iron almost red hot. So that if the earth had no atmosphere, the moon would be as visible in total eclipses as she is when new. If the moon were so near the earth as to go into its dark shadow, suppose about *p o*, she would be invisible during her stay in it; but visible before and after in the fainter shadow RR.

When the moon goes thro' the centre of the earth's shadow, she is directly opposite to the sun; yet the moon has been often seen totally eclipsed in the horizon when the sun was also visible in the opposite part of it: for the horizontal refraction being almost 34 minutes of a degree, and the diameter of the sun and moon being each at a mean state but 32 minutes, the refraction causes both luminaries to appear above the horizon when they are really below it.

When the moon is full at 12 degrees from either of her nodes, she just touches the earth's shadow, but enters not into it. In fig. 204. let GH be the ecliptic, *ef* the moon's orbit where she is 12 degrees from the node at her full; *c d* her orbit where she is 6 degrees from the node, *a b* her orbit where she is full in the node, AB the earth's shadow, and M the moon. When the moon describes the line *e f*, she just touches the shadow, but does not enter into it; when she describes the line *c d*, she is totally, though not centrally, immersed in the shadow; and when she describes the line *a b*, she passes by the node at M in the centre of the shadow, and takes the longest line possible, which is a diameter, through it: and such an eclipse being both total and central is of the longest duration, namely, 3 hours 57 minutes 6 seconds from the beginning to the end, if the moon be at her greatest distance from the earth; and 3 hours 37 minutes 26 seconds, if she be at her least distance. The reason of this difference is, that when the moon is farthest from the earth, she moves slowest; and when nearest to it, quickest.

The moon's diameter, as well as the sun's, is supposed to be divided into 12 equal parts, called *digits*; and so many of these parts as are darkened by the earth's shadow, so many digits is the moon eclipsed. All that the moon is eclipsed above 12 digits, shows how far the shadow of the earth is over the body of the moon, on that edge to which she is nearest at the middle of the eclipse.

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448 Lunar eclipses difficultly observed.

It is difficult to observe exactly either the beginning or ending of a lunar eclipse, even with a good telescope, because the earth's shadow is so faint and ill-defined about the edges, that when the moon is either just touching or leaving it, the obscuration of her limb is scarce sensible; and therefore the nicest observers can hardly be certain to four or five seconds of time. But both the beginning and ending of solar eclipses are visibly instantaneous; for the moment that the edge of the moon's disk touches the sun's, his roundness seems a little broke on that part; and the moment she leaves it, he appears perfectly round again.

449 Eclipses useful in determining longitudes, &c.

In astronomy, eclipses of the moon are of a great use for ascertaining the periods of her motions; especially such eclipses as are observed to be alike in all her circumstances, and have long intervals of time between them. In geography, the longitudes of places are found by eclipses: but for this purpose eclipses of the moon are more useful than those of the sun, because they are more frequently visible, and the same lunar eclipse is of equal largeness and duration at all places where it is seen. In chronology, both solar and lunar eclipses serve to determine exactly the time of any past event: for there are so many particulars observable in every eclipse, with respect to its quantity, the places where it is visible (if of the sun), and the time of the day or night, that it is impossible there can be two solar eclipses in the course of many ages which are alike in all circumstances.

450 Darkness of our Saviour's crucifixion supernatural.

From the above explanation of the doctrine of eclipses, it is evident, that the darkness at our Saviour's crucifixion was supernatural. For he suffered on the day on which the passover was eaten by the Jews, on which day it was impossible that the moon's shadow could fall on the earth; for the Jews kept the passover at the time of full moon: nor does the darkness in total eclipses of the sun last above four minutes in any place; whereas the darkness at the crucifixion lasted three hours, Math. xxviii. 15. and overspread at least all the land of Judea.

451 Construction of tables for calculating eclipses.

The theory of eclipses being now, we hope, pretty plainly laid down, the construction of tables for their calculation will be understood from the following considerations.

The motions of the sun and moon are observed to be continually accelerated from the apogee to the perigee, and as gradually retarded from the perigee to the apogee; being slowest of all when the mean anomaly is nothing, and swiftest of all when it is six signs.

When the luminary is in its apogee or perigee, its place is the same as it would be if its motion were equable in all parts of its orbit. The supposed equable motions are called *mean*; the unequable are justly called the *true*.

The mean place of the sun or moon is always forwarder than the true place, whilst the luminary is moving from its apogee to its perigee: and the true

place

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place is always forwarder than the mean, whilſt the luminary is moving from its perigee to its apogee. In the former caſe the anomaly is always leſs than ſix ſigns; and in the latter caſe, more.

It has been found by a long ſeries of obſervations, that the ſun goes through the ecliptic, from the vernal equinox to the ſame equinox again, in 365 days, 5 hours 48 minutes 55 ſeconds; from the firſt ſtar of Aries to the ſame ſtar again, in 365 days 6 hours 9 minutes 24 ſeconds; and from his apogee to the ſame again, in 365 days 6 hours 14 minutes 0 ſeconds.—The firſt of theſe is called the *ſolar year*; the ſecond the *ſidereal year*; and the third the *anomaliſtic year*. So that the ſolar year is 20 minutes 29 ſeconds ſhorter than the ſidereal; and the ſidereal year is 4 minutes 36 ſeconds ſhorter than the anomaliſtic. Hence it appears, that the equinoctial point, or interſection of the ecliptic and equator at the beginning of Aries, goes backward with reſpect to the fixed ſtars, and that the ſun's apogee goes forward.

It is alſo obſerved that the moon goes through her orbit, from any given fixed ſtar to the ſame ſtar again, in 27 days 7 hours 43 minutes 4 ſeconds at a mean rate; and from her apogee to her apogee again, in 27 days 13 hours 18 minutes 43 ſeconds; and from the ſun to the ſun again, in 29 days 12 hours 44 minutes $3\frac{1}{4}$ ſeconds. This ſhows that the moon's apogee moves forward in the ecliptic, and that at a much quicker rate than the ſun's apogee does: ſince the moon is 5 hours 55 minutes 39 ſeconds longer in revolving from her apogee to her apogee again, than from any ſtar to the ſame ſtar again.

The moon's orbit croſſes the ecliptic in two oppoſite points, which are called her *Nodes*: and it is obſerved, that ſhe revolves ſooner from any node to the node again, than from any ſtar to the ſtar again, by 2 hours 38 minutes 27 ſeconds; which ſhows that her nodes move backward, or contrary to the order of ſigns in the ecliptic.

The time in which the moon revolves from the ſun to the ſun again (or from change to change) is called the *Lunation*; which according to Dr Pound's mean meaſures, would always conſiſt of 29 days 12 hours 44 minutes 3 ſeconds 2 thirds 58 fourths, if the motions of the ſun and moon were always equable. Hence 12 mean lunations contain 354 days 8 hours 48 minutes 36 ſeconds 35 thirds 40 fourths, which is 10 days 21 hours 11 minutes 23 ſeconds 24 thirds 20 fourths leſs than the length of a common Julian year, conſiſting of 365 days 6 hours; and 13 mean lunations contain 383 days 21 hours 32 minutes 39 ſeconds 38 thirds 38 fourths, which exceeds the length of a common Julian year, by 18 days 15 hours 32 minutes 39 ſeconds 38 thirds 38 fourths.

The mean time of new moon being found for any given year and month, as ſuppoſe for March 1700, old ſtyle, if this mean new moon falls later than the 11th day of March, then 12 mean lunations added to the time of this mean new moon will give the time of the mean new moon in March 1701, after having thrown off 365 days. But when the mean new moon happens to be before the 11th of March, we muſt add 13 mean lunations, in order to have the time of mean new moon in March the year following; always taking care to ſubtract 365 days in common years, and 366 days in leap years, from the ſum of this addition.

Thus A. D. 1700, old ſtyle, the time of mean new moon in March was the 8th day, at 16 hours 11 minutes 25 ſeconds after the noon of that day (viz. at 11 minutes 25 ſeconds paſt four in the morning of the 9th day, according to common reckoning. To this we muſt add 13 mean lunations, or 383 days 21 hours 32 minutes 39 ſeconds 38 thirds 38 fourths, and the ſum will be 392 days 13 hours 44 minutes 4 ſeconds 38 thirds 38 fourths: from which ſubtract 365 days, becauſe the year 1701 is a common year, and there will remain 27 days 13 hours 44 minutes 4 ſeconds 38 thirds 38 fourths for the time of a mean new moon in March, A. D. 1701.

Carrying on this addition and ſubtraction till A. D. 1703, we find the time of mean new moon in March that year to be on the 6th day, at 7 hours 21 minutes 17 ſeconds 49 thirds 46 fourths paſt noon; to which add 13 mean lunations, and the ſum will be 390 days 4 hours 53 minutes 57 ſeconds 28 thirds 20 fourths; from which ſubtract 366 days, becauſe the year 1704 is a leap year, and there will remain 24 days 4 hours 53 minutes 57 ſeconds 28 thirds 20 fourths, for the time of mean new moon in March, A. D. 1704.

In this manner was the firſt of the following tables conſtructed to ſeconds, thirds, and fourths; and then wrote out to the neareſt ſeconds. The reaſon why we choſe to begin the year with March, was to avoid the inconvenience of adding a day to the tabular time in leap-years after February, or ſubtracting a day therefrom in January and February in thoſe years; to which all tables of this kind are ſubject, which begin the year with January, in calculating the times of new or full moons.

The mean anomalies of the ſun and moon, and the ſun's mean motion from the aſcending node of the moon's orbit, are ſet down in Table III. from 1 to 13 mean lunations. Theſe numbers, for 13 lunations, being added to the radical anomalies of the ſun and moon, and to the ſun's mean diſtance from the aſcending node, at the time of mean new moon in March 1700 (Table I.), will give their mean anomalies, and the ſun's mean diſtance from the node, at the time of mean new moon in March 1701; and being added for 12 lunations to thoſe for 1701, give them for the time of mean new moon in March 1702. And ſo on as far as you pleaſe to continue the table (which is here carried on to the year 1800), always throwing off 12 ſigns when their ſum exceeds 12, and ſetting down the remainder as the proper quantity.

If the numbers belonging to A. D. 1700 (in Table I.) be ſubtracted from thoſe belonging to 1800, we ſhall have their whole differences in 100 complete Julian years; which accordingly we find to be 4 days 8 hours 10 minutes 52 ſeconds 15 thirds 40 fourths, with reſpect to the time of mean new moon. Theſe being added together 60 times (always taking care to throw off a whole lunation when the days exceed $29\frac{1}{2}$) make up 60 centuries, or 6000 years, as in Table VI. which was carried on to ſeconds, thirds, and fourths; and then wrote out to the neareſt ſeconds. In the ſame manner were the reſpective anomalies and the ſun's diſtance from the node found, for theſe centurial

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torial years; and then (for want of room) wrote out only to the neareſt minutes, which is ſufficient in whole centuries. By means of theſe two tables, we may find the time of any mean new moon in Mareh, together with the anomalies of the ſun and moon, and the ſun's diſtance from the node, at theſe times within the limits of 6000 years, either before or after any given year in the 18th century; and the mean time of any new or full moon in any given month after Mareh, by means of the third and fourth tables, within the ſame limits, as ſhown in the precepts for calculation.

Thus it would be a very eaſy matter to calculate the time of any new or full moon, if the ſun and moon moved equably in all parts of their orbits. But we have already ſhown, that their places are never the ſame as they would be by equable motions, except when they are in apogee or perigee; which is, when their mean anomalies are either nothing, or ſix ſigns: and that their mean places are always forwarder than their true places, whilſt the anomaly is leſs than ſix ſigns; and their true places are forwarder than the mean, whilſt the anomaly is more.

Hence it is evident, that while the ſun's anomaly is leſs than ſix ſigns, the moon will overtake him, or be oppoſite to him, ſooner than ſhe could if his motion were equable; and later whilſt his anomaly is more than ſix ſigns. The greateſt difference that can poſſibly happen between the mean and true time of new or full moon, on account of the inequality of the ſun's motion, is 3 hours 48 minutes 28 ſeconds: and that is, when the ſun's anomaly is either 3 ſigns 1 degree, or 8 ſigns 29 degrees; ſooner in the firſt caſe, and later in the laſt.—In all other ſigns and degrees of anomaly, the difference is gradually leſs, and vaniſhes when the anomaly is either nothing or ſix ſigns.

The ſun is in his apogee on the 30th of June, and in his perigee on the 30th of December, in the preſent age: ſo that he is nearer the earth in our winter than in our ſummer.—The proportional difference of diſtance, deduced from the difference of the ſun's apparent diameter at theſe times, is as 983 to 1017.

The moon's orbit is dilated in winter, and contracted in ſummer; therefore the lunations are longer in winter than in ſummer. The greateſt difference is found to be 22 minutes 29 ſeconds; the lunations increaſing gradually in length whilſt the ſun is moving from his apogee to his perigee, and decreaſing in length whilſt he is moving from his perigee to his apogee.—On this account, the moon will be later every time in coming to her conjunction with the ſun, or being in oppoſition to him, from December till June, and ſooner from June till December, than if her orbit had continued of the ſame ſize all the year round.

As both theſe differences depend on the ſun's anomaly, they may be fitly put together into one table, and called *The annual or firſt equation of the mean to the true ſyzygy*, (ſee Table VII.) This equational difference is to be ſubtracted from the time of the mean ſyzygy when the ſun's anomaly is leſs than ſix ſigns, and added when the anomaly is more.—At the greateſt it is 4 hours 10 minutes 57 ſeconds, viz. 3 hours 48 minutes 28 ſeconds, on account of the ſun's unequal motion, and 22 minutes 29 ſeconds, on account of the dilatation of the moon's orbit.

This compound equation would be ſufficient for reducing the mean time of new or full moon to the true time thereof, if the moon's orbit were of a circular form, and her motion quite equable in it. But the moon's orbit is more elliptical than the ſun's, and her motion in it ſo much the more unequal. The difference is ſo great, that ſhe is ſometimes in conjunction with the ſun, or in oppoſition to him, ſooner by 9 hours 47 minutes 54 ſeconds, than ſhe would be if her motion were equable; and at other times as much later. The former happens when her mean anomaly is 9 ſigns 4 degrees, and the latter when it is 2 ſigns 26 degrees. See Table IX.

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At different diſtances of the ſun from the moon's apogee, the figure of the moon's orbit becomes different. It is longeſt of all, or moſt eccentric, when the ſun is in the ſame ſign and degree either with the moon's apogee or perigee; ſhorteſt of all, or leaſt eccentric, when the ſun's diſtance from the moon's apogee is either three ſigns or nine ſigns; and at a mean ſtate when the diſtance is either 1 ſign 15 degrees, 4 ſigns 15 degrees, 7 ſigns 15 degrees, or 10 ſigns 15 degrees. When the moon's orbit is at its greateſt eccentricity, her apogeal diſtance from the earth's centre is to her perigeal diſtance therefrom, as 1067 is to 933; when leaſt eccentric, as 1043 is to 957; and when at the mean ſtate, as 1055 is to 945.

But the ſun's diſtance from the moon's apogee is equal to the quantity of the moon's mean anomaly at the time of new moon, and by the addition of ſix ſigns it becomes equal in quantity to the moon's mean anomaly at the time of full moon. Therefore, a table may be conſtructed ſo as to anſwer to all the various inequalities depending on the different eccentricities of the moon's orbit, in the ſyzygies, and called *The ſecond equation of the mean to the true ſyzygy*. (See Table IX.): and the moon's anomaly, when equated by Table VIII. may be made the proper argument for taking out this ſecond equation of time; which muſt be added to the former equated time, when the moon's anomaly is leſs than ſix ſigns, and ſubtracted when the anomaly is more.

There are ſeveral other inequalities in the moon's motion, which ſometimes bring on the true ſyzygy a little ſooner, and at other times keep it back a little later, than it would otherwiſe be: but they are ſo ſmall, that they may be all omitted except two; the former of which (ſee Table X.) depends on the difference between the anomalies of the ſun and moon in the ſyzygies, and the latter (ſee Table XI.) depends on the ſun's diſtance from the moon's nodes at theſe times.—The greateſt difference ariſing from the former is 4 minutes 48 ſeconds; and from the latter, 1 minute 34 ſeconds.

452 Directions for the uſe of thoſe tables.

The tables here inſerted being calculated by Mr Ferguſon according to the methods already given, he gives the following directions for their uſe.

To calculate the true Time of New or full Moon.

Precept I. If the required time be within the limits of the 18th century, write out the mean time of new moon in March, for the propoſed year, from Table I. in the old ſtyle, or from Table II. in the new; together with the mean anomalies of the ſun and moon, and the ſun's mean diſtance from the moon's aſcending node. If you want the time of full moon in March, add the half lunation at the foot of Table III. with its

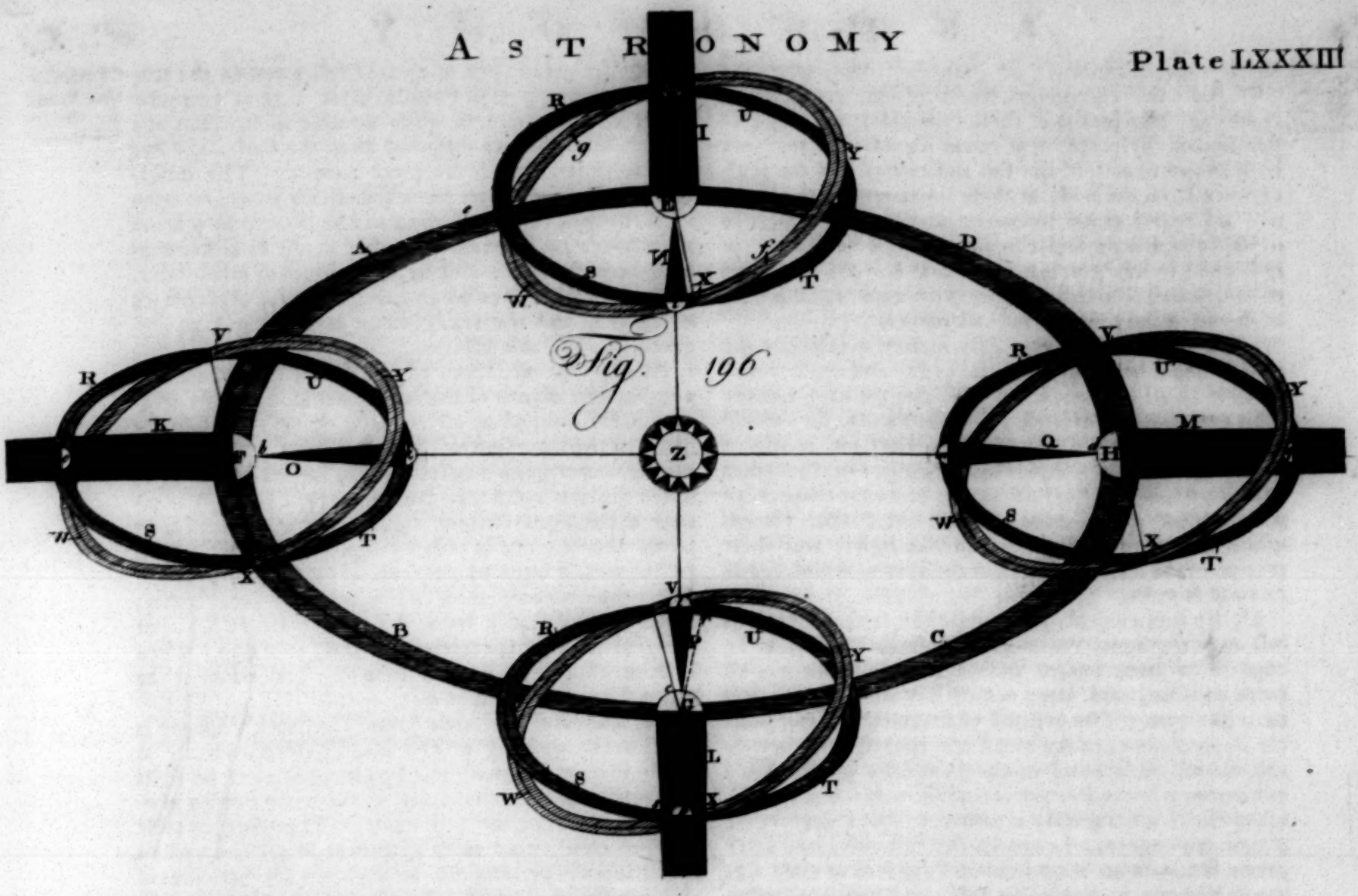

Fig. 196

Fig. 197

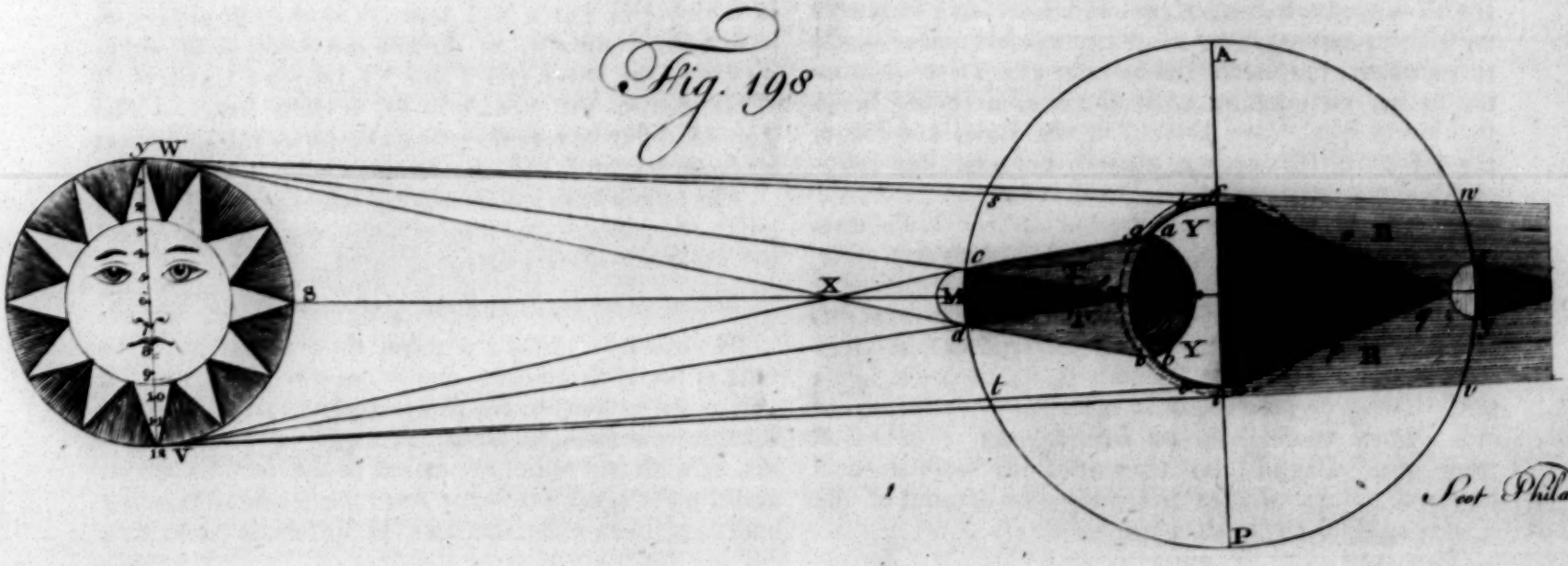

Fig. 198

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its anomalies, &c. to the former numbers, if the new moon falls before the 15th of March; but if it falls after, ſubtract the half lunation, with the anomalies, &c. belonging to it, from the former numbers, and write down the reſpective ſums or remainders.

II. In theſe additions or ſubtractions, obſerve, that 60 ſeconds make a minute, 60 minutes make a degree, 30 degrees make a ſign, and 12 ſigns make a circle. When you exceed 12 ſigns in addition, reject 12, and ſet down the remainder. When the number of ſigns to be ſubtracted is greater than the number you ſubtract from, add 12 ſigns to the leſſer number, and then you will have a remainder to ſet down. In the tables ſigns are marked thus ', degrees thus °, minutes thus ′, and ſeconds thus ″.

III. When the required new or full moon is in any given month after March, write out as many lunations with their anomalies, and the ſun's diſtance from the node from Table III. as the given month is after March, ſetting them in order below the numbers taken out for March.

IV. Add all theſe together, and they will give the mean time of the required new or full moon, with the mean anomalies and ſun's mean diſtance from the aſcending node, which are the arguments for finding the proper equations.

V. With the number of days added together, enter Table IV. under the given month; and againſt that number you have the day of mean new or full moon in the left-hand column, which ſet before the hours, minutes, and ſeconds, already found.

But (as it will ſometimes happen) if the ſaid number of days fall ſhort of any in the column under the given month, add one lunation and its anomalies, &c. (from Table III.) to the foreſaid ſums, and then you will have a new ſum of days wherewith to enter Table IV. under the given month, where you are ſure to find it the ſecond time, if the firſt falls ſhort.

VI. With the ſigns and degrees of the ſun's anomaly, enter Table VII. and therewith take out the annual or firſt equation for reducing the mean ſyzygy to the true; taking care to make proportions in the table for the odd minutes and ſeconds of anomaly, as the table gives the equation only to whole degrees.

Obſerve, in this and every other caſe of finding equations, that if the ſigns are at the head of the table, their degrees are at the left hand, and are reckoned downwards; but if the ſigns are at the foot of the table, their degrees are at the right hand, and are counted upward; the equation being in the body of the table, under or over the ſigns, in a collateral line with the degrees. The titles *Add* or *Subtract* at the head or foot of the tables where the ſigns are found, ſhow whether the equation is to be added to the mean time of new or full moon, or to be ſubtracted from it. In this table the equation is to be ſubtracted, if the ſigns of the ſun's anomaly are found at the head of the table; but it is to be added, if the ſigns are at the foot.

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VII. With the ſigns and degrees of the ſun's mean anomaly, enter Table VIII. and take out the equation of the moon's mean anomaly; ſubtract this equation from her mean anomaly, if the ſigns of the ſun's anomaly be at the head of the table, but add it if they are at the foot; the reſult will be the moon's equated anomaly, with which enter table IX. and take out the ſecond equation for reducing the mean to the true time of new or full moon; adding this equation, if the ſigns of the moon's anomaly are at the head of the table, but ſubtracting it if they are at the foot; and the reſult will give you the mean time of the required new or full moon twice equated, which will be ſufficiently near for common almanacs.—But when you want to calculate an eclipſe, the following equations muſt be uſed: thus,

VIII. Subtract the moon's equated anomaly from the ſun's mean anomaly, and with the remainder in ſigns and degrees enter Table X. and take out the third equation, applying it to the former equated time, as the titles *Add* or *Subtract* do direct.

IX. With the ſun's mean diſtance from the aſcending node enter Table XI. and take out the equation anſwering to that argument, adding it to, or ſubtracting it from, the former equated time, as the titles direct, and the reſult will give the time of new or full moon, agreeing with well regulated clocks or watches very near the truth. But to make it agree with the ſolar, or apparent time, you muſt apply the equation of natural days, taken from an equation-table, as it is leap-year, or the firſt, ſecond, or third after. This, however, unleſs in very nice calculations, needs not be regarded, as the difference between true and apparent time is never very conſiderable.

The method of calculating the time of any new or full moon without the limits of the 18th century, will be ſhown further on. And a few examples compared with the precepts will make the whole work plain.

N. B. The tables begin the day at noon, and reckon forward from thence to the noon following.—Thus, March the 31ſt, at 22 ho. 30 min. 25 ſec. of tabular time, is April 1ſt (in common reckoning) at 30 min. 25 ſec. after 10 o'clock in the morning.

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EXAMPLE I.

Required the true time of New Moon in April 1764, *New Style?*

By the Precepts.

	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	o	′	″	s	o	′	″	s	o	′	″
March 1764,	2	8	55	36	8	2	20	0	10	13	35	21	11	4	54	48
Add 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
Mean New Moon,	31	21	39	39	9	1	26	19	11	9	24	21	0	5	35	2
First Equation,	+	4	10	40	11	10	59	18	+	1	34	57				
Time once equated,	32	1	50	19	9	20	27	1	11	10	59	18	Sun from Node, and Arg. 4th equation.			
Second Equation,	—	3	24	49	Arg. 3d. equation				Arg. 2d equation.							
Time twice equated,	31	22	25	30												
Third Equation,		+	4	37												
Time thrice equated,	31	22	30	7												
Fourth Equation,			+	18												
True New Moon,	31	22	30	25												
Equation of days,		—	3	48												
Apparent time,	31	22	26	37												

So the true time is 22 h. 30 min. 25 ſec. after the noon of the 31ſt March; that is, April 1ſt, at 30 min. 25 ſec. after ten in the morning. But the apparent time is 26 min. 37 ſec. after ten in the morning.

EXAMPLE II.

454 Qu. *The true time of the Full Moon in* May 1762, *New Style?*

By the Precepts,

	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	o	′	″	s	o	′	″	s	o	′	″
March 1762,	24	15	18	24	8	23	48	16	1	23	59	11	10	18	49	14
Add 2 Lunations,	59	1	28	6	1	28	12	39	1	21	38	1	2	1	20	28
New Moon, May,	22	16	46	30	10	22	0	55	3	15	37	12	0	20	9	42
Subt. ¼ Lunation,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full Moon, May,	7	22	24	28	10	7	27	45	9	2	42	42	0	4	49	35
First equation,	+	3	16	36	9	3	57	18	+	1	14	36				
Time once equated,	8	1	41	4	1	3	30	27	9	3	57	18	Sun from Node, and Arg. fourth equation.			
Second Equation,	—	9	47	53	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	7	15	53	11												
Third Equation,		—	2	36												
Time thrice equated,	7	15	50	35												
Fourth Equation,			+	15												
The Full Moon,	7	15	50	50												

Anſ. May 7th at 15 h. 50 min. 50 ſec. paſt noon, *viz.* May 8th at 3 h. 50 min. 50 ſec. in the morning.

455 *To calculate the time of New and Full Moon in a given year and month of any particular century, between the Chriſtian æra and the* 18*th century.*

PRECEPT I. Find a year of the ſame number in the 18th century with that of the year in the century propoſed, and take out the mean time of new moon in March, old ſtyle, for that year, with the mean anomalies and ſun's mean diſtance from the node at that time, as already taught.

II. Take as many complete centuries of years from Table VI. as, when ſubtracted from the aboveſaid year in the 18th century, will anſwer to the given year; and take out the firſt mean new moon and its anomalies, &c. belonging to the ſaid centuries, and ſet them below thoſe taken out for March in the 18th century.

III. Subtract the numbers belonging to theſe centuries from thoſe of the 18th century, and the remainders will be the mean time and anomalies, &c. of new moon, in March, in the given year of the century propoſed,—Then, work in all reſpects for the true time of new or full moon, as ſhown in the above precepts and examples.

IV. If the days annexed to theſe centuries exceed the number of days from the beginning of March taken out in the 18th century, add a lunation and its anomalies, &c. from Table III. to the time and anomalies of new moon in March, and then proceed in all reſpects as above.—This circumſtance happens in Example V.

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EXAMPLE III.

Required the true time of Full Moon, in April, Old Style, A. D. 30?

From 1730 subtract 1700 (or 17 centuries) and there remains 30.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s.	o.	′	″	s.	o.	′	″	s.	o.	′	″
March 1730,	7	12	34	16	8	18	4	31	9	0	32	17	1	23	17	16
Add ⅓ Lunation,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full Moon,	22	6	56	18	9	2	37	41	3	13	26	47	2	8	37	23
1700 years subtr.	14	17	36	42	11	28	46	0	10	29	36	0	4	29	23	0
Full ☽ March A. D. 30.	7	13	19	36	9	3	51	41	4	13	50	47	9	9	14	23
Add 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
Full Moon, April,	6	2	3	39	10	2	58	0	5	9	39	47	10	9	54	37
First Equation,	+	3	28	4	5	10	58	40	+	1	18	53				
Time once equated,	6	5	31	43	4	21	59	20	5	10	58	40	Sun from Node,			
Second Equation,	+	2	57	48	Arg. 3d equation.				Arg. 2d equation.				and Arg. fourth equation.			
Time twice equated,	6	8	29	31												
Third Equation,		—	2	54												
Time thrice equated,	6	8	26	37												
Fourth Equation,		—	1	33												
True Full Moon, April,	6	8	25	4												

Hence it appears, that the true time of Full Moon in April, A. D. 30, old style, was on the 6th day at 25 m. 4 s. past eight in the evening.

456 *To calculate the true time of New or Full Moon in any given year and month before the Christian æra.*

PRECEPT I. Find a year in the 18th century, which being added to the given number of years before Christ diminished by one, shall make a number of complete centuries.

II. Find this number of centuries in Table VI. and subtract the time and anomalies belonging to it from those of the mean new moon in March, the above-found year of the 18th century; and the remainder will denote the time and anomalies, &c. of mean new moon in March, the given year before Christ.—Then, for the true time thereof in any month of that year, proceed as above taught.

EXAMPLE IV.

Required the true time of New Moon in May, *Old Style, the year before Christ 585?*

The years 584 added to 1716, makes 2300, or 23 centuries.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s.	o	′	″	s.	o	′	″	s.	o	′	″
March 1716,	11	17	33	29	8	22	50	39	4	4	14	2	4	27	17	5
2300 years subtract,	11	5	57	53	11	19	47	0	1	5	59	0	7	25	27	0
March before Christ 585,	0	11	35	36	9	3	3	39	2	28	15	2	9	1	50	5
Add 3 Lunations,	88	14	12	9	2	27	18	58	2	17	27	1	3	2	0	42
May before Christ 585,	28	1	47	45	0	0	22	37	5	15	42	3	0	3	50	47
First Equation,		—	1	37	5	15	41	17			—	46				
Time once equated,	28	1	46	8	6	14	41	20	5	15	41	17	Sun from Node,			
Second Equation,	+	2	15	1	Arg. 3d equation.				Arg. 2d equation.				and Arg. fourth equation.			
Time twice equated,	28	4	1	9												
Third Equation,		+	1	9												
Time thrice equated,	28	4	2	18												
Fourth Equation,			+	12												
True New Moon,	28	4	2	30												

So the true time was May 28th, at 2 minutes 30 seconds past four in the afternoon.

These Tables are calculated for the meridian of London; but they will serve for any other place, by subtracting four minutes from the tabular time, for every degree that the meridian of the given place is westward of London, or adding four minutes for every degree that the meridian of the given place is eastward: as in

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EXAMPLE V.

Required the true time of Full Moon at Alexandria *in* Egypt *in* September, *Old Style, the year before Chriſt* 201?

The years 200 added to 1800, make 2000, or 20 centuries.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	o	′	″	s	o	′	″	s	o	′	″
March 1800,	13	0	22	17	8	23	19	55	10	7	52	36	11	3	58	24
Add 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
From the ſum,	42	13	6	20	9	22	26	14	11	3	41	36	0	4	38	38
Subtract 2000 years,	27	18	9	19	0	8	50	0	0	15	42	0	6	27	45	0
N. M. bef. Chr. 201,	14	18	57	1	9	13	36	14	10	17	59	36	5	6	53	38
Add 6 Lunations,	177	4	24	18	5	24	37	56	5	4	54	3	6	4	1	24
Add half Lunations,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full Moon, September,	22	17	43	21	3	22	47	20	10	5	48	9	11	26	15	9
Firſt Equation,	—	3	52	6	10	4	19	55	—	1	28	14	Sun from Node, and Argument fourth equation.			
Time once equated,	22	13	51	15	5	18	27	25	10	4	19	55				
Second Equation,	—	8	25	4	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	22	5	26	11												
Third Equation,			—	58												
Time thrice equated,	22	5	25	13												
Fourth Equation,			—	12												
True time at London,	22	5	25	1												
Add for Alexandria,		2	1	27												
True time there,	22	7	26	28												

Thus it appears, that the true time of Full Moon at Alexandria, in September, old ſtyle, the year before Chriſt 201, was the 22d day, at 26 minutes 28 ſeconds after ſeven in the evening.

EXAMPLE VI.

Required the true time of Full Moon at Babylon *in* October, *Old Style, the* 4008 *year before the firſt year of Chriſt, or* 4007 *before the year of his birth?*

The years 4007 added to 1793, make 5800, or 58 centuries.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M	S.	s	o	′	″	s	o	′	″	s	o	′	″
March 1793,	30	9	13	55	9	10	26	11	8	7	37	58	7	6	18	26
Subtract 5800 years,	15	12	38	7	10	21	35	0	6	24	43	0	9	13	1	0
N. M. bef. Chr. 4007,	14	20	35	48	10	18	41	11	1	12	54	58	9	23	17	26
Add 7 Lunations,	206	17	8	21	6	23	44	15	6	0	43	3	7	4	41	38
Add half Lunations.	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full Moon, October,	22	8	6	11	5	26	58	36	1	26	32	31	5	13	19	11
Firſt Equation,		—	13	26	1	26	27	26		—	5	5	Sun from Node, and Argument fourth equation.			
Time once equated,	22	7	52	45	4	0	31	10	1	26	27	26				
Second Equation,	+	8	29	21	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	22	16	22	6												
Third Equation,		—	4	10												
Time thrice equated,	22	16	17	56												
Fourth Equation,			—	51												
Full Moon at London,	22	16	17	5												
Add for Babylon,		2	25	41												
True time there,	22	18	42	46												

So that, on the meridian of London, the true time was October 23d, at 17 minutes 5 ſeconds paſt four in the morning; but at Babylon, the true time was October 23d, at 42 minutes 46 ſeconds paſt ſix in the morning.—This is ſuppoſed by ſome to have been the year of the creation.

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To calculate the true time of New or Full Moon in any given year and month after the 18th century.

PRECEPT I. Find a year of the same number in the 18th century with that of the year proposed, and take out the mean time and anomalies, &c. of new moon in March, old style, for that year, in Table I.

II. Take so many years from Table VI. as when added to the abovementioned year in the 18th century will answer to the given year in which the new or full moon is required; and take out the first new moon, with its anomalies for these complete centuries.

III. Add all these together, and then work in all respects as above shown, only remember to subtract a lunation and its anomalies, when the abovesaid addition carries the new moon beyond the 31st of March; as in the following example.

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EXAMPLE VII.

Required the true time of New Moon in July, *Old Style*, A. D. 2180?

Four centuries (or 400 years) added to A. D. 1780, make 2180.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	o	′	″	s	o	′	″	s	o	′	″
March 1780,	23	23	1	44	9	4	18	13	1	21	7	47	10	18	21	1
Add 400 years.	17	8	43	29	0	13	24	0	10	1	28	0	6	17	49	0
From the sum	41	7	45	13	9	17	42	13	11	22	35	47		6	10	1
Subtract 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0		0	40	14
New Moon March 2180,	11	19	1	10	8	18	35	54	10	26	46	47	4	5	29	47
Add 4 Lunations,	118	2	56	12	3	26	25	17	3	13	16	2	4	2	40	56
New Moon July 2180.	7	21	57	22	0	15	1	11	2	10	2	49	8	8	10	43
First Equation,	—	1	3	39	3	9	38	37		—	24	12	Sun from Node, and Argument fourth equation.			
Time once equated,	7	20	53	43	10	5	22	34	2	9	38	37				
Second Equation,	+	9	24	8	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	8	6	17	51												
Third Equation,		+	3	56												
Time thrice equated,	8	6	21	47												
Fourth Equation,		+	1	8												
True time, July,	8	6	22	55												

True time, July 8th, at 22 minutes 55 seconds past six in the evening.

In keeping by the old style, we are always sure to be right, by adding or subtracting whole hundreds of years to or from any given year in the 18th century. But in the new style we may be very apt to make mistakes, on account of the leap-year's not coming in regularly every fourth year: and therefore, when we go without the limits of the 18th century, we had best keep to the old style, and at the end of the calculation reduce the time to the new. Thus, in the 22d century there will be fourteen days difference between the styles; and therefore the true time of new moon in this last example being reduced to the new style, will be the 22d of July, at 22 minutes 55 seconds past six in the evening.

459 *To calculate the true place of the Sun for any given moment of time.*

PRECEPT I. In Table XII. find the next lesser year in number to that in which the sun's place is sought, and write out his mean longitude and anomaly answering thereto: to which add his mean motion and anomaly for the complete residue of years, months, days, hours, minutes and seconds, down to the given time, and this will be the sun's mean place and anomaly at that time, in the old style, provided the said time be in any year after the Christian æra. *See the first following Example.*

II. Enter Table XIII. with the sun's mean anomaly, and making proportions for the odd minutes and seconds thereof, take out the equation of the sun's centre: which, being applied to his mean place as the title *Add* or *Subtract* directs, will give his true place or longitude from the vernal equinox, at the time for which it was required.

III. To calculate the sun's place for any time in a given year before the Christian æra, take out his mean longitude and anomaly for the first year thereof, and from these numbers subtract the mean motions and anomalies for the complete hundreds or thousands next above the given year; and to the remainders, add those for the residue of years, months, &c. and then work in all respects as above. *See the second Example following.*

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EXAMPLE I.

Required the Sun's true place, March 20th *Old Style,* 1764, *at* 22 *hours* 30 *minutes* 25 *ſeconds paſt noon? In common reckoning,* March 21ſt, *at* 10 *hours* 30 *minutes* 25 *ſeconds in the forenoon.*

			Sun's Longitude.				Sun's Anomaly.			
			s	o	′	″	s	o	′	″
To the radical year after Chriſt	—	1701	9	20	43	50	6	13	1	0
Add complete years	—	60	0	0	27	12	11	29	26	0
		3	11	29	17	0	11	29	14	0
		March	1	28	9	11	1	28	9	0
Biſſextile Days	—	20		20	41	55		20	41	55
Hours	—	22			54	13			54	13
Minutes	—	30			1	14			1	14
Seconds	—	25				1				1
Sun's mean place at the given time	— — — —		0	10	14	36	9	1	27	23
Equation of the Sun's centre, add	— — — —			1	55	36	Mean Anomaly.			
Sun' true place at the ſame time	— — — —		0	12	10	12	or ♈ 12	10	12	

EXAMPLE II.

Required the Sun's true place, October 23d, *Old Style, at* 16 *hours* 57 *minutes paſt noon, in the* 4008th *year before the year of Chriſt* 1; *which was the* 4007th *before the year of his birth, and the year of Julian period* 706.

By the Precepts.

			Sun's Longitude.				Sun's Anomaly.			
			s	o	′	″	s	o	′	″
From the radical numbers after Chriſt	— — —	1	9	7	53	10	6	28	48	0
Subtract thoſe for 5000 complete years	— — — —		1	7	46	40	10	13	25	0
Remains for a new radix			8	0	6	30	8	15	23	0
To which add, to bring it to the given time: complete years	— —	900	0	6	48	0	11	21	37	0
		80	0	0	36	16	11	29	15	0
		12	0	0	5	26	11	29	53	0
		October	8	29	4	54	8	29	4	0
Days		23		22	40	12		22	40	12
Hours		16			39	26			39	26
Minutes,		57			2	20			2	20
Sun's mean place at the given time	— — —		6	0	3	4	5	28	33	58
Equation of the ſun's centre ſubtract	— — — —				3	4	Sun's Anomaly.			
Sun's true place at the ſame time	— — — — —		6	0	0	0	or ♎ 0	0	0	

So that in the meridian of London, the ſun was then juſt entering the ſign ♎ Libra, and conſequently was upon the point of the autumnal equinox.

If to the above time of the autumnal equinox at London, we add 2 hours 25 minutes 41 ſeconds for the longitude of Babylon, we ſhall have for the time of the ſame equinox, at that place, October 23d, at 19 hours 22 minutes 41 ſeconds; which, in the common way of reckoning, is October 24th, at 22 minutes 41 ſeconds paſt ſeven in the morning.

And it appears by Example VI. that in the ſame year, the true time of full moon at Babylon was October 23d, at 42 minutes 46 ſeconds after ſix in the morning; ſo that the autumnal equinox was on the day next after the day of full moon.—The dominical letter for that year was G, and conſequently the 24th of October was on a Wedneſday.

To find the Sun's diſtance from the Moon's aſcending node, at the time of any given new or full moon; and conſequently to know whether there is an eclipſe at that time, or not. 460

The ſun's diſtance from the moon's aſcending node is the argument for finding the moon's fourth equation in the ſyzygies, and therefore it is taken into all the foregoing examples in finding the times thereof. Thus, at the time of mean new moon in April 1764, the ſun's mean diſtance from the aſcending node, is 0° 5° 35′ 2″. See Example I. p. 562.

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The descending node is opposite to the ascending one, and they are just six signs distant from each other.

When the sun is within 17 degrees of either of the nodes at the time of new moon, he will be eclipsed at that time: and when he is within 12 degrees of either of the nodes at the time of full moon, the moon will be then eclipsed. Thus we find, that there was an eclipse of the sun at the time of new moon in April 1764.

But the true time of that new moon comes out by the equations to be 50 minutes 46 seconds later than the mean time thereof, by comparing these times in the above example: and therefore we must add the sun's motion from the node during that interval to the above mean distance 0ˢ 5° 35′ 2″, which motion is found in Table XII. for 50 minutes 46 seconds, to be 2′ 12″. And to this we must apply the equation of the sun's mean distance from the node in Table XV. found by the sun's anomaly, which at the mean time of new moon in Example I. is 9ˢ 1° 26′ 19″; and then we shall have the sun's true distance from the node, at the true time of new moon, as follows:

	Sun from Node. s	°	′	″
At the mean time of new moon in April 1764	0	5	35	2
Sun's motion from the node for 50 minutes 46 seconds			2	10
				2
Sun's mean distance from node at true new moon	0	5	37	14
Equation of mean distance from node, add		2	5	0
Sun's true distance from the ascending node	0	7	42	14

Which being far within the above limit of 17 degrees, shows that the sun must then have been eclipsed.

And now we shall show how to project this, or any other eclipse, either of the sun or moon.

461 *To project an Eclipse of the Sun.*

In order to this, we must find the 10 following elements, by means of the tables.

1. The true time of conjunction of the sun and moon; and at that time. 2. The semidiameter of the earth's disk, as seen from the moon, which is equal to the moon's horizontal parallax. 3. The sun's distance from the solstitial colure to which he is then nearest. 4. The sun's declination. 5. The angle of the moon's visible path with the ecliptic. 6. The moon's latitude. 7. The moon's true horary motion from the sun. 8. The sun's semidiameter. 9. The moon's. 10. The semidiameter of the penumbra.

We shall now proceed to find these elements for the sun's eclipse in April 1764.

462 *To find the true time of new moon.* This, by Example I. p. 562, is found to be on the first day of the said month, at 30 minutes 25 seconds after ten in the morning.

463 2. *To find the moon's horizontal parallax, or semidiameter of the earth's disk, as seen from the moon.* Enter Table XVII. with the signs and degrees of the moon's anomally (making proportions, because the anomaly is in the table only to every 6th degree), and thereby take out the moon's horizontal parallax; which for the above time, answering to the anomaly 11ˢ 9° 24′ 21″, is 54′ 43″.

464 3. *To find the sun's distance from the nearest solstice,* viz. *the beginning of Cancer, which is* 3ˢ *or* 90° *from the beginning of Aries.* It appears by Example I. in p. 566 (where the sun's place is calculated to the above time of new moon), that the sun's longitude from the beginning of Aries is then 0ˢ 12° 10′ 12″; that is, the sun's place at that time is ♈ Aries, 12° 10′ 12″.

	s	°	′	″
Therefore from - -	3	0	0	0
Subtract the Sun's longitude or place	0	12	10	12
Remains the sun's distance from the solstice ♋	=2	17	49	48

Or 77° 49′ 48″; each sign containing 30 degrees.

465 5. *To find the sun's declination.* Enter Table XIV. with the signs and degrees of the sun's true place, viz. 0ˢ 12°, and making proportions for the 10′ 12″, take out the sun's declination answering to his true place, and it will be found to be 4° 49′ north.

466 5. *To find the moon's latitude.* This depends on her distance from her ascending node, which is the same as the sun's distance from it at the time of new moon; and is thereby found in Table XVI.

But we have already found, that the sun's equated distance from the ascending node, at the time of new moon in April 1764, is 0ˢ 7° 42′ 14″. See above.

Therefore, enter Table XVI. with 0 signs at the top, and 7 and 8 degrees at the left hand, and take out 36′ and 39″, the latitude for 7°; and 41′ 51″, the latitude for 8°: and by making proportions between these latitudes for the 42′ 14″, by which the moon's distance from the node exceeds 7 degrees; her true latitude will be found to be 40′ 18″ north ascending.

467 6. *To find the moon's true horary motion from the sun.* With the moon's anomaly, viz. 11ˢ 9° 24′ 21″, Table XVII. and take out the moon's horary motion; which, by making proportions in that table, will be found to be 30′ 22″. Then, when the sun's anomaly, 9ˢ 1° 26′ 19″, take out his horary motion 2′ 28″ from the same table: and subtracting the latter from the former, there will remain 27′ 54″ for the moon's true horary motion from the sun.

468 7. *To find the angle of the moon's visible path with the ecliptic.* This, in the projection of eclipses, may be always rated at 5° 35′, without any sensible error.

469 8, 9. *To find the semidiameters of the sun and moon.* These are found in the same table, and by the same arguments, as their horary motions. In the present case, the sun's anomaly gives his semidiameters 16′ 6″, and the moon's anomaly gives her semidiameter 14′ 57″.

470 10. *To find the semidiameter of the penumbra.* Add the moon's semidiameter to the sun's, and their sum will be the semidiameter of the penumbra, viz. 31′ 3″.

Now collect these elements, that they may be found the more readily when they are wanted in the construction of this eclipse.

1. True

Of calculating Eclipses, &c.

1. True time of new moon in April, 1764 - -	1	10	30	25
		°	′	″
2. Semidiameter of the earth's disk		0	54	53
3. Sun's distance from the nearest solst.		77	49	48
4. Sun's declination, north		4	49	0
5. Moon's latitude, north ascending		0	40	18
6. Moon's horary motion from the sun		0	27	54
7. Angle of the moon's visible path with the ecliptic		5	35	0
8. Sun's semidiameter			16	6
9. Moon's semidiameter			14	57
10. Semidiameter of the penumbra			31	3

To project an Eclipse of the Sun geometrically.

Make a scale of any convenient length, as AC, and divide it into as many equal parts as the earth's semidisk contains minutes of a degree; which, at the time of the eclipse in April 1764, is 54′ 53″. Then, with the whole length of the scale as a radius, describe the semicircle AMB upon the centre C; which semicircle shall represent the northern half of the earth's enlightened disk, as seen from the sun.

Upon the centre C raise the straight line CH, perpendicular to the diameter ACB; so ACB shall be a part of the ecliptic, and CH its axis.

Being provided with a good sector, open it to the radius CA in the line of chords; and taking from thence the chord of 23½ degrees in your compasses, set it off both ways from H, to *g* and to *h*, in the periphery of the semidisk; and draw the straight line *g* V *h*, in which the north pole of the disk will be always found.

When the sun is in Aries, Taurus, Gemini, Cancer, Leo, and Virgo, the north pole of the earth is enlightened by the sun; but whilst the sun is in the other six signs, the south pole is enlightened, and the north pole is in the dark.

And when the sun is in Capricorn, Aquarius, Pisces, Aries, Taurus, and Gemini, the northern half of the earth's axis C XII P lies to the right hand of the axis of the ecliptic, as seen from the sun; and to the left hand, whilst the sun is in the other six signs.

Open the sector till the radius (or distance of the two 90's) of the lines be equal to the length of V *h*, and take the line of the sun's distance from the solstice (77° 49′ 48″) as nearly as you can guess, in your compasses, from the line of lines, and set off that distance from V to P in the line *g* V *h*, because the earth's axis lies to the right hand of the axis of the ecliptic in this case, the sun being in Aries; and draw the straight line C XII P for the earth's axis, of which P is the north pole. If the earth's axis had lain to the left hand from the axis of the ecliptic, the distance VP would have been set off from V towards *g*.

To draw the parallel of latitude of any given place, as suppose London, or the path of that place on the earth's enlightened disk as seen from the sun, from sunrise till sun-set, take the following method.

Subtract the latitude of London, 51°½ from 90°, and the remainder 38°½ will be the co-latitude, which take in your compasses from the line of chords, making CA or CB the radius, and set it from *h* (Where the earth's axis meets the periphery of the disk) to VI and VI, and draw the occult or dotted line VI K VI. Then, from the points where this line meets the earth's disk, set off the chord of the sun's declination 4° 49′ to D and F, and to E and G, and connect these points by the two occult lines F XII G and DLE. Of calculating Eclipses, &c.

Bisect LK XII in K, and through the point K draw the black line VI K VI. Then making CB the radius of a line of lines on the sector, take the co-latitude of London 38°½ from the lines in your compasses, and set it both ways from K to VI and VI. These hours will be just in the edge of the disk at the equinoxes, but at no other time in the whole year.

With the extent K VI taken into your compasses, set one foot in K (in the black line below the occult one) as a centre, and with the other foot describe the semicircle VI 7 8 9 10, &c. and divide it into 12 equal parts. Then from these points of division draw the occult lines 7*p*, 8*o*, 9*n*, &c. parallel to the earth's axis C XII P.

With the small extent K XII as a radius, describe the quadrantal arc XII*f*, and divide it into six equal parts, as XII *a*, *ab*, *bc*, *cd*, *de*, and *ef*; and through the division-points *a*, *b*, *c*, *d*, *e*, draw the occult lines VII *e* V, VIII *d* IV, IX *c* III, X *b* II, and XI *a* I, all parallel to VI K VI, and meeting the former occult lines 7 *p* 8 *o*, &c. in the points VII VIII IX X XI, V IV III II and I: which points shall mark the several situations of London on the earth's disk, at these hours respectively, as seen from the sun; and the elliptic curve VI VII VII, &c. being drawn through these points, shall represent the parallel of latitude, or path of London on the disk, as seen from the sun, from its rising to its setting.

N. B. If the sun's declination had been south, the diurnal path of London would have been on the upper side of the line VI K VI, and would have touched the line DLE in L. It is requisite to divide the horary spaces into quarters (as some are in the figure), and, if possible, into minutes also.

Make CB the radius of a line of chords on the sector, and taking therefrom the chord of 5° 35′, the angle of the moon's visible path with the ecliptic, set it off from H to M on the left hand of CH, the axis of the ecliptic, because the moon's latitude is north ascending. Then draw CM for the axis of the moon's orbit, and bisect the angle MCH by the right line C*z*. If the moon's latitude had been north descending, the axis of her orbit would have been on the right hand from the axis of the ecliptic.——N. B. The axis of the moon's orbit lies the same way when her latitude is south ascending as when it is north ascending; and the same way when south descending as when north descending.

Take the moon's latitude 40′ 18″ from the scale C A in your compasses, and set it from *i* to *x* in the bisecting line C*z*, making *ix* parallel to C*y*: and thro' *x*, at right angles to the axis of the moon's orbit CM, draw the straight line N *wxy*S for the path of the penumbra's centre over the earth's disk.—The point *w*, in the axis of the moon's orbit, is that where the penumbra's centre approaches nearest to the centre of the earth's disk, and consequently is the middle of the general eclipse: the point *x* is that where the conjunction

of

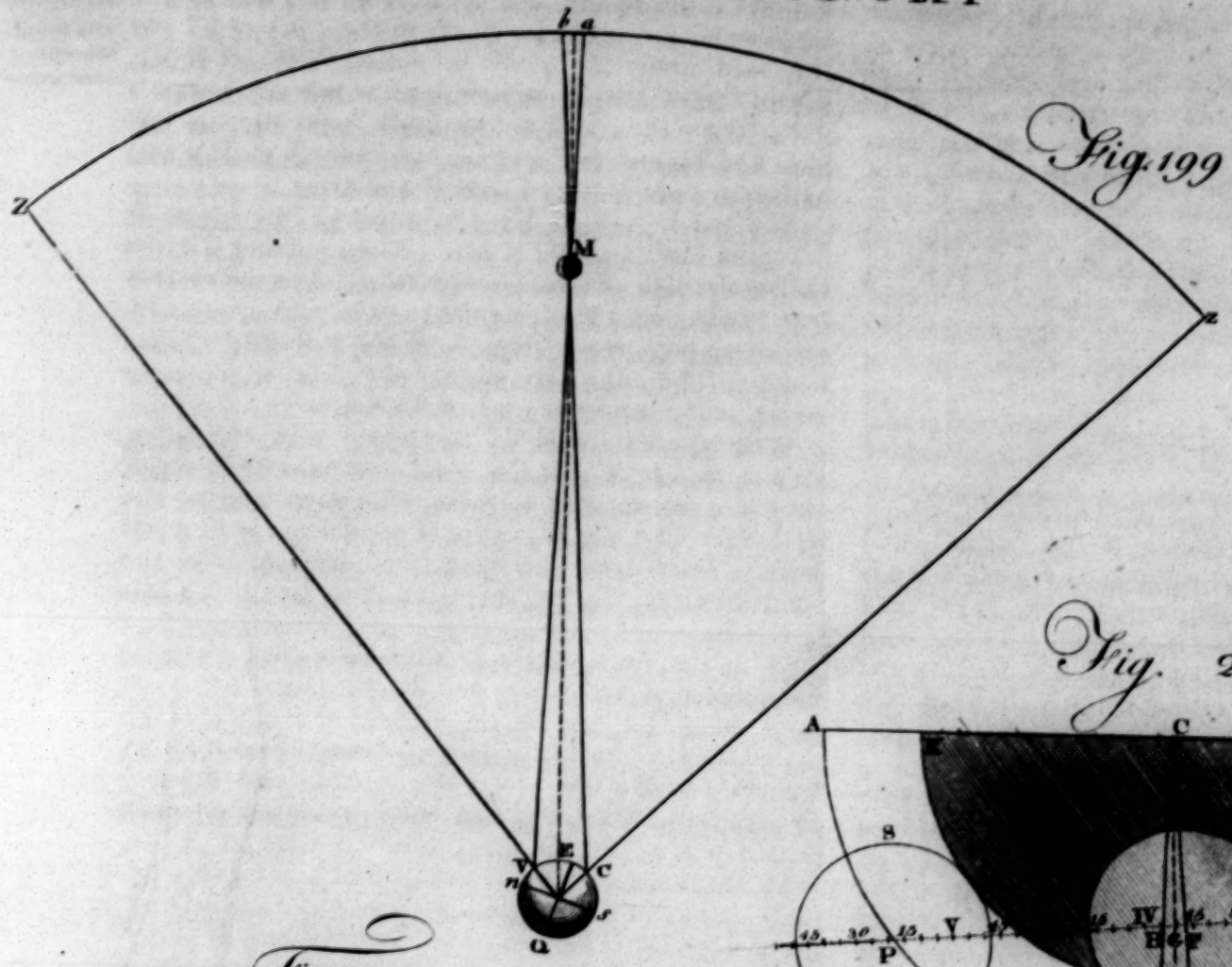
Fig. 199
Fig. 201
60 50 40 30 20 10 0
W X

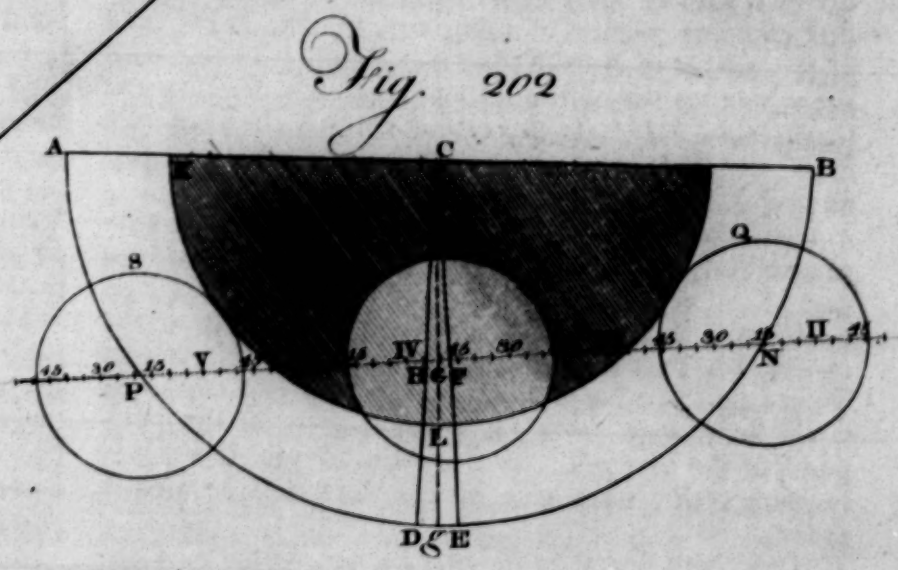
Fig. 202
A C B
S Q
P N
L
D g E

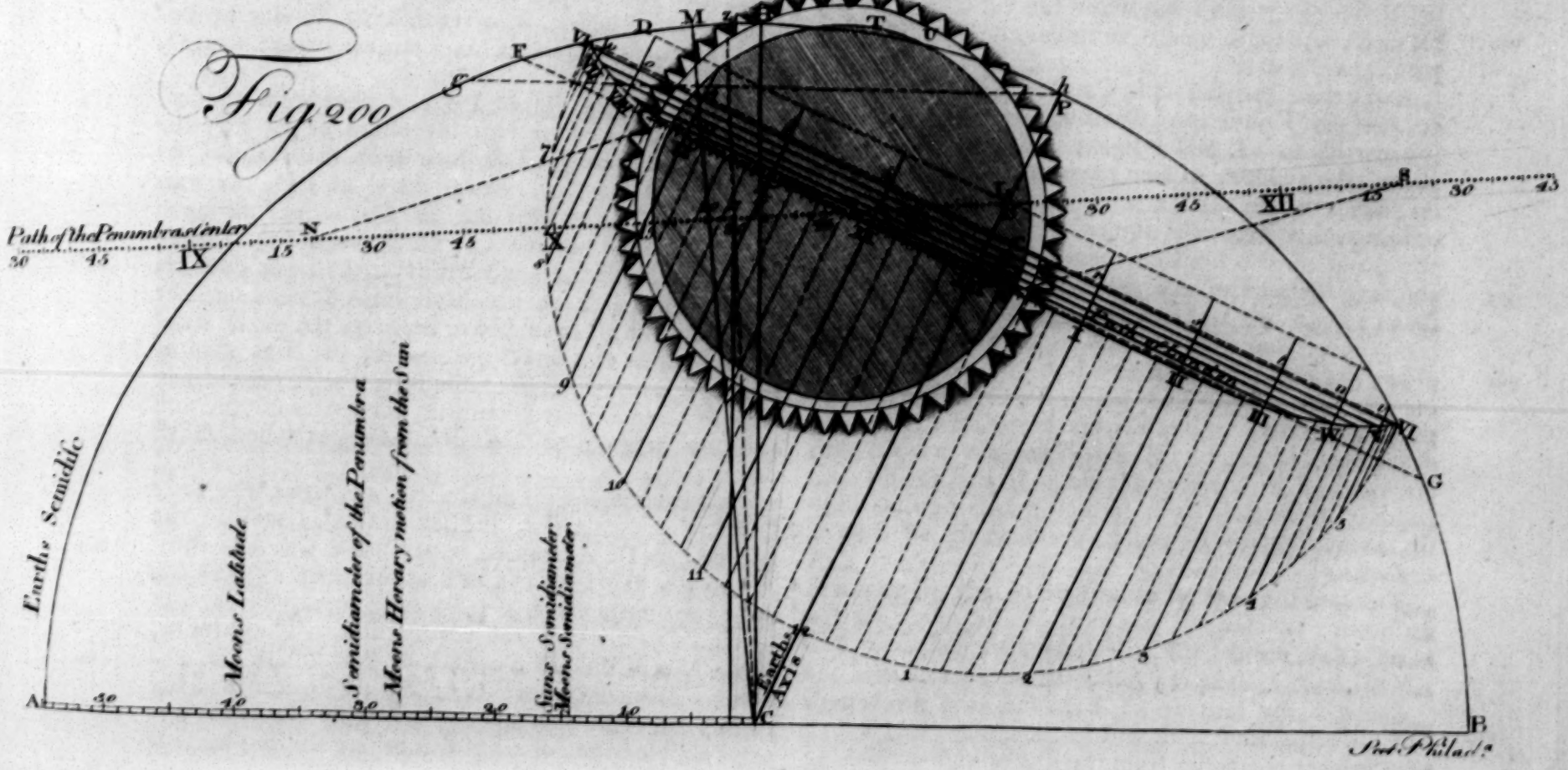
Fig. 200
Path of the Penumbra's Center
Earths Semidiac
Moons Latitude
Semidiameter of the Penumbra
Moons Horary motion from the Sun
Suns Semidiameter
Moons Semidiameter
Earths Axis
Pert. Philad.

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of the ſun and moon falls, according to equal time by the tables; and the point *y* is the ecliptical conjunction of the ſun and moon.

Take the moon's true horary motion from the ſun, 27′ 54″, in your compaſſes, from the ſcale CA (every diviſion of which is a minute of a degree), and with that extent make marks along the path of the penumbra's centre; and divide each ſpace from mark to mark into ſixty equal parts or horary minutes, by dots; and ſet the hours to every 60th minute in ſuch a manner, that the dot ſignifying the inſtant of new moon by the tables, may fall into the point *x*, half way between the axis of the moon's orbit and the axis of the ecliptic; and then, the reſt of the dots will ſhow the points of the earth's diſk, where the penumbra's centre is at the inſtants denoted by them, in its tranſit over the earth.

Apply one ſide of a ſquare to the line of the penumbra's path, and move the ſquare backwards and forwards until the other ſide of it cuts the ſame hour and minute (as at *m* and *m*) both in the path of London and in the path of the penumbra's centre; and the particular minute or inſtant which the ſquare cuts at the ſame time in both paths, ſhall be the inſtant of the viſible conjunction of the ſun and moon, or greateſt obſcuration of the ſun, at the place for which the conſtruction is made, namely, London, in the preſent example; and this inſtant is at 47¼ minutes paſt ten o'clock in the morning; which is 17 minutes five ſeconds later than the tabular time of true conjunction.

Take the ſun's ſemidiameter, 16′ 6″, in your compaſſes, from the ſcale CA, and ſetting one foot in the path of London, at *m*, namely at 47¼ minutes paſt ten, with the other foot deſcribe the circle UY, which ſhall repreſent the ſun's diſk as ſeen from London at the greateſt obſcuration.—Then take the moon's ſemidiameter, 14′ 57″, in your compaſſes from the ſame ſcale; and ſetting one foot in the path of the penumbra's centre at *m*, in the 47¼ minute after ten, with the other foot deſcribe the circle TY for the moon's diſk, as ſeen from London, at the time when the eclipſe is at the greateſt, and the portion of the ſun's diſk which is hid or cut off by the moon's will ſhow the quantity of the eclipſe at that time; which quantity may be meaſured on a line equal to the ſun's diameter, and divided into 12 equal parts for digits.

Laſtly, take the ſemidiameter of the penumbra, 31′ 3″, from the ſcale CA in your compaſſes; and ſetting one foot in the line of the penumbra's central path, on the left hand from the axis of the ecliptic, direct the other foot toward the path of London; and carry that extent backwards and forwards till both the points of the compaſſes fall into the ſame inſtants in both the paths: and theſe inſtants will denote the time when the eclipſe begins at London.—Then, do the like on the right hand of the axis of the ecliptic; and where the points of the compaſſes fall into the ſame inſtants in both of the paths, they will ſhow at what time the eclipſe ends at London.

Theſe trials give 20 minutes after nine in the morning for the beginning of the eclipſe at London, at the points N and O; 47¼ minutes after ten, at the points *m* and *n*, for the time of greateſt obſcuration; and 18 minutes after twelve, at R and S, for the time when the eclipſe ends; according to mean or equal time.

From theſe times we may ſubtract the equation of natural days, &c. 3 minutes 48 ſeconds, in leap-year April 1, and we ſhall have the apparent times; namely, 9 hours 16 minutes 12 ſeconds for the beginning of the eclipſe, 10 hours 43 minutes 42 ſeconds for the time of greateſt obſcuration, and 12 hours 14 minutes 12 ſeconds for the time when the eclipſe ends. But the beſt way is to apply this equation to the true equal time of new moon, before the projection be begun; as is done in Example I. For the motion or poſition of places on the earth's diſk anſwer to apparent or ſolar time.

Of calculating Eclipſes, &c.

In this conſtruction it is ſuppoſed, that the angle under which the moon's diſk is ſeen, during the whole time of the eclipſe, continues invariably the ſame; and that the moon's motion is uniform and rectilineal during that time. But theſe ſuppoſitions do not exactly agree with the truth; and therefore, ſuppoſing the elements given by the tables to be accurate, yet the times and phaſes of the eclipſe, deduced from its conſtruction, will not anſwer exactly to what paſſeth in the heavens; but may be at leaſt two or three minutes wrong, though done with the greateſt care. Moreover, the paths of all places of conſiderable latitudes, are nearer the centre of the earth's diſk, as ſeen from the ſun, than thoſe conſtructions make them: becauſe the diſk is projected as if the earth were a perfect ſphere although it is known to be a ſpheroid. Conſequently, the moon's ſhadow will go farther northward in all places of northern latitude, and farther ſouthward in all places of ſouthern latitude, than it is ſhown to do in theſe projections.—According to Meyer's Tables, this eclipſe was about a quarter of an hour ſooner than either theſe tables, or Mr Flamſtead's or Dr Halley's, make it, and was not annular at London. But M. de la Caille's make it almoſt central.

The projection of lunar eclipſes.

When the moon is within 12 degrees of either of her nodes at the time when ſhe is full, ſhe will be eclipſed, otherwiſe not. 472

We find by example ſecond, page 562, that at the time of mean full moon in May 1762, the ſun's diſtance from the aſcending node was only 4° 49′ 35″; and the moon being then oppoſite to the ſun, muſt have been juſt as near her deſcending node, and was therefore eclipſed.

The elements for conſtructing an eclipſe of the moon, are eight in number, as follow:

1. The true time of full moon; and at that time. 472
2. The moon's horizontal parallax. 3. The ſun's ſemidiameter. 4. The moon's. 5. The ſemidiameter of the earth's ſhadow at the moon. 6. The moon's latitude. 7. The angle of the moon's viſible path with the ecliptic. 8. The moon's true horary motion from the ſun.——Therefore,

1. *To find the true time of new or full moon.* Work as already taught in the precepts.—Thus we had the true time of full moon in May 1762 (See Example II. page 562) on the 8th day, at 50 minutes 50 ſeconds paſt three o'clock in the morning. 473

2. *To find the moon's horizontal parallax.* Enter Table XVII. with the moon's mean anomaly (at the above full) 9ˢ 2° 42′ 42″, and thereby take out her horizontal parallax, which by making the requiſite proportions, will be found to be 57′ 23″. 474

3, 4. *To find the ſemidiameters of the ſun and moon.* Enter Table XVII. with their reſpective anomalies, the ſun's being 10ˢ 7° 27′ 45″ (by the above example) and the moon's 9ˢ 2° 42′ 42″; and thereby take out their reſpective ſemidiameters; the ſun's 15′ 56″, and the moon's 15′ 38″. 475

Of calculating Eclipses, &c.

476 *5. To find the ſemidiameter of the earth's ſhadow at the moon.* Add the ſun's horizontal parallax, which is always 10″, to the moon's which in the preſent caſe is 57′ 23″, the ſum will be 57′ 33″, from which ſubtract the ſun's ſemidiameter 15′ 56″, and there will remain 41′ 36″ for the ſemidiameter of that part of the earth's ſhadow which the moon then paſſes through.

477 *6. To find the moon's latitude.* Find the ſun's true diſtance from the aſcending node (as already taught in page 566) at the true time of full moon; and this diſtance increaſed by ſix ſigns, will be the moon's true diſtance from the ſame node; and conſequently the argument for finding her true latitude, as ſhown in p. 566.

478 Thus, in Example II. the ſun's mean diſtance from the aſcending node was 0ˢ 4° 49′ 35″, at the time of mean full moon: but it appears by the example, that the true time thereof was ſix hours 33 minutes 38 ſeconds ſooner than the mean time; and therefore we muſt ſubtract the ſun's motion from the node (found in Table XII.) during this interval, from the above mean diſtance 0ˢ 4° 49′ 35″, in order to have his mean diſtance from it at the true time of full moon. Then to this apply the equation of his mean diſtance from the node, found in Table XV. by his mean anomaly 10ˢ 7° 27′ 45″; and laſtly add ſix ſigns: ſo ſhall the moon's true diſtance from the aſcending node be found as follows:

	s	o	′	″
Sun from node at mean full moon	0	4	49	35
His motion from it in 6 hours			15	35
His motion from it in 33 minutes			1	26
His motion from it in 38 ſeconds				2
Sum, ſubtract from the uppermoſt line			17	3
Remains his mean diſtance at true full moon	0	4	32	32
Equation of his mean diſtance, add		1	38	0
Sun's true diſtance from the node	0	6	10	32
To which add	6	0	0	0
And the ſum will be	6	6	10	32

Which is the moon's true diſtance from her aſcending node at the true time of her being full; and conſequently the argument for finding her true latitude at that time.—Therefore, with this argument, enter Table XVI. making proportions between the latitudes belonging to the 6th and 7th degree of the argument at the left hand (the ſigns being at top) for the 10′ 32″ and it will give 32′ 21″ for the moon's true latitude, which appears by the table to be ſouth deſcending.

479 *7. To find the angle of the moon's viſible path with the ecliptic.* This may be ſtated at 5° 35′, without any error of conſequence in the projection of the eclipſe.

480 *8. To find the moon's true horary motion from the ſun.* With their reſpective anomalies take out their horary motions from Table XVII. and the ſun's horary motion ſubtracted from the moon's leaves remaining the moon's true horary motion from the ſun: in the preſent caſe 30′ 52″.

481 Now collect theſe elements together for uſe.

	D.	H.	M.	S.
1. True time of full moon in May, 1762	8	3	50	50
	o	′	″	
2. Moon's horizontal parallax	0	57	23	
3. Sun's ſemidiameter	0	15	56	
4. Moon's ſemidiameter	0	15	38	
5. Semidiameter of the earth's ſhadow at the moon	0	41	37	
6. Moon's true latitude, ſouth deſcending	0	32	21	
7. Angle of her viſible path with the ecliptic	5	35	0	
8. Her true horary motion from the ſun	0	30	52	

Theſe elements being found for the conſtruction of the moon's eclipſe in May 1762, proceed as follows:

Make a ſcale of any convenient length, as WX (fig. 201.), and divide it into 60 equal parts, each part ſtanding for a minute of a degree. Of calculating eclipſes, &c.

Draw the right line ACB (fig. 202.) for part of the ecliptic, and CD perpendicular thereto for the ſouthern part of its axis; the moon having ſouth latitude.

Add the ſemidiameters of the moon and earth's ſhadow together, which in this eclipſe will make 57′ 15″; and take this from the ſcale in your compaſſes, and ſetting one foot in the point C as a centre, with the other foot deſcribe the ſemicircle ADB; in one point of which the moon's centre will be at the beginning of the eclipſe, and in another at the end thereof.

Take the ſemidiameter of the earth's ſhadow, 41′ 37″, in your compaſſes from the ſcale, and ſetting one foot in the centre C, with the other foot deſcribe the ſemicircle KLM for the ſouthern half of the earth's ſhadow, becauſe the moon's latitude is ſouth in this eclipſe.

Make CD equal to the radius of a line of chords on the ſector, and ſet off the angle of the moon's viſible path with the ecliptic, 5° 35′, from D to E, and draw the right line CFE for the ſouthern half of the axis of the moon's orbit lying to the right hand from the axis of the ecliptic CD, becauſe the moon's latitude is ſouth deſcending.—It would have been the ſame way (on the other ſide of the ecliptic) if her latitude had been north deſcending; but contrary in both caſes, if her latitude had been either north aſcending or ſouth aſcending.

Biſect the angle DCE by the right line C*g*; in which line the true equal time of oppoſition of the ſun and moon falls, as given by the tables.

Take the moon's latitude, 32′ 21″ from the ſcale with your compaſſes, and ſet it from C to G, in the line C*g*; ond through the point G, at right angles to CFE, draw the right line PHGFN for the path of the moon's centre. Then, F ſhall be the point in the earth's ſhadow, where the moon's centre is at the middle of the eclipſe: G, the point where her centre is at the tabular time of her being full; and H, the point where her centre is at the inſtant of her ecliptical oppoſition.

Take the moon's horary motion from the ſun, 30′ 52″, in your compaſſes from the ſcale; and with that extent make marks along the line of the moon's path PGN: then divide each ſpace from mark to mark, into 60 equal parts, or horary minutes, and ſet the hours to the proper dots in ſuch a manner, that the dot ſignifying the inſtant of full moon (viz. 50 minutes 50 ſeconds after III in the morning) may be in the point G, where the line of the moon's path cuts the line that biſects the angle DCE.

Take the moon's ſemidiameter, 15′ 38″, in your compaſſes from the ſcale, and with that extent, as a radius, upon the points N, F, and P, as centres, deſcribe the circle Q for the moon at the beginning of the eclipſe, when ſhe touches the earth's ſhadow at V; the circle R for the moon at the middle of the eclipſe; and the circle S for the moon at the end of the eclipſe, juſt leaving the earth's ſhadow at W.

The point N denotes the inſtant when the eclipſe began, namely, at 15 minutes 10 ſeconds after II in the morning: the point F the middle of the eclipſe at 47 minutes 44 ſeconds paſt III; and the point P the the end of the eclipſe, at 18 minutes after V.—At the greateſt obſcuration the moon was 10 digits eclipſed.

TABLES

TABLE I. *The mean Time of New Moon, in* March, *Old Style; with the mean Anomalies of the Sun and Moon, and the Sun's mean Distance from the Moon's ascending Node, from* A. D. 1700 *to* A. D. 1800 *inclusive.*

A. D.	Mean N. Moon in March.	Sun's mean Anomaly.	Moon's mean Anomaly.	Sun's mean Dist. from the Node.
	D. H. M. S.	s o ′ ″	s o ′ ″	s o ′ ″
1700	8 16 11 25	8 19 58 48	1 22 30 37	6 14 31 7
1701	27 13 44 5	9 8 20 59	0 28 7 42	7 23 24 8
1702	16 22 32 41	8 27 36 51	11 7 55 47	8 0 16 55
1703	6 7 21 18	8 16 52 43	9 17 43 52	8 9 19 42
1704	24 4 53 57	9 5 14 54	8 23 20 57	9 18 2 43
1705	13 13 42 34	8 24 30 47	7 3 9 2	9 26 5 30
1706	2 22 31 11	8 13 46 39	5 12 57 7	10 4 8 17
1707	21 20 3 50	9 2 8 50	4 18 34 13	11 12 51 18
1708	10 4 52 27	8 21 24 43	2 28 22 18	11 20 54 5
1709	29 2 25 7	9 9 46 54	2 3 59 24	0 29 37 6
1710	18 11 13 43	8 29 2 47	0 13 47 30	1 7 39 54
1711	7 20 2 20	8 18 18 39	10 23 35 36	1 15 42 41
1712	25 17 34 59	9 6 40 51	9 29 12 42	2 14 25 43
1713	15 2 23 36	8 25 56 43	8 9 0 47	3 2 28 30
1714	4 11 12 13	8 15 12 35	6 18 48 52	3 10 31 17
1715	23 8 44 52	9 3 34 47	5 24 25 57	4 19 14 18
1716	11 17 33 29	8 22 50 39	4 4 14 2	4 27 17 5
1717	1 2 22 5	8 12 6 32	2 14 2 8	5 5 19 52
1718	19 23 54 45	9 0 28 44	1 19 39 13	6 14 2 54
1719	9 8 43 22	8 19 44 37	11 29 27 18	6 22 5 41
1720	27 6 16 1	9 8 6 49	11 5 4 24	8 0 48 43
1721	16 15 4 38	8 27 22 41	9 14 52 29	8 8 51 29
1722	5 23 53 14	8 16 38 33	7 24 40 34	8 16 54 16
1723	24 21 25 54	9 5 0 45	7 0 17 40	9 25 37 18
1724	13 6 14 31	8 24 16 37	5 10 5 45	0 3 40 5
1725	2 15 3 7	8 13 32 29	3 19 53 50	10 11 42 52
1726	21 12 35 47	9 1 54 41	2 25 30 56	11 20 25 54
1727	10 21 24 23	8 21 10 34	1 5 19 1	11 28 28 41
1728	28 18 57 3	9 9 52 46	0 10 56 7	1 7 11 42
1729	18 3 45 40	8 28 48 39	10 20 44 12	1 15 14 29
1730	7 12 34 16	8 18 4 31	9 0 32 17	1 23 17 16
1731	26 10 6 56	9 6 26 42	8 6 9 23	3 2 0 17
1732	14 18 55 33	8 25 42 34	6 15 57 28	3 10 3 4
1733	4 3 44 9	8 14 58 26	4 25 45 38	3 18 5 51
1734	23 1 16 49	9 3 20 38	4 1 22 39	4 26 48 53
1735	12 10 5 25	8 22 36 30	2 11 10 44	5 4 51 40
1736	0 18 54 2	8 11 52 22	0 20 58 49	5 12 54 27
1737	19 16 26 42	9 0 14 34	11 26 35 55	6 21 37 29
1738	9 1 15 18	8 19 30 26	10 6 24 0	6 29 40 16
1739	27 22 47 58	9 7 52 38	9 12 1 6	8 8 23 18
1740	16 7 36 34	8 27 8 30	7 21 49 11	8 16 26 5
1741	5 16 25 11	8 16 24 22	6 1 37 16	8 24 28 52
1742	42 13 57 52	9 4 46 34	5 7 14 22	10 3 11 54
1743	3 22 46 27	8 24 2 27	3 17 2 27	10 1 14 41
1744	2 7 35 4	8 13 18 20	1 26 50 32	10 19 17 28
1745	21 5 7 44	9 1 40 32	1 2 27 38	11 28 0 30
1746	10 13 56 20	8 20 56 24	11 12 15 43	0 6 3 17
1747	29 11 29 0	9 9 98 36	10 17 52 49	1 14 46 19
1748	17 20 17 36	8 28 34 28	8 27 40 54	1 22 49 5
1749	7 5 6 13	8 17 50 20	7 7 28 59	2 0 51 52
1750	26 2 38 53	9 6 12 32	6 13 6 5	3 9 34 53
1751	15 11 27 29	8 25 28 24	4 22 54 10	3 17 37 40
1752	3 20 16 6	8 14 44 16	3 2 42 15	3 25 40 27
1753	22 17 48 45	9 3 6 28	2 8 19 21	5 4 23 28
1754	12 2 37 22	8 22 22 20	0 18 7 26	5 12 26 15
1755	1 11 25 59	8 11 38 12	10 27 55 31	5 20 29 2
1756	19 8 58 38	9 0 0 24	10 3 32 37	6 29 12 3
1757	8 17 47 15	8 19 16 16	8 13 20 42	7 7 14 50
1758	27 15 19 54	9 7 38 28	7 18 57 48	8 15 57 52
1759	17 0 8 31	8 26 54 20	5 28 45 54	8 24 0 39
1760	5 8 57 8	8 16 10 12	4 8 34 0	9 2 3 26
1761	24 6 29 47	9 4 32 24	3 14 11 6	10 10 46 27
1762	13 15 18 24	8 23 48 16	1 23 59 11	10 18 49 14
1763	3 0 7 1	8 13 4 8	0 3 47 16	10 26 52 1
1764	20 21 39 40	9 1 26 20	11 9 24 21	0 5 35 2
1765	10 6 28 17	8 20 42 13	9 19 12 26	0 13 37 49
1766	29 4 0 56	9 9 4 20	8 24 49 32	1 22 20 51
1767	18 12 49 33	8 28 20 17	7 4 37 37	2 0 23 38
1768	6 21 38 10	8 17 36 9	5 14 25 42	2 8 26 25
1769	25 19 10 40	9 5 58 21	4 20 2 48	3 17 9 27
1770	15 3 59 26	8 25 14 13	2 29 50 53	3 25 12 14
1771	4 12 48 2	8 14 30 5	1 9 38 58	4 3 15 1
1772	22 10 20 43	9 2 52 17	0 15 16 4	5 11 58 3
1773	11 19 9 19	8 22 8 9	10 25 4 9	5 20 0 50
1774	1 3 57 55	8 11 24 1	9 4 52 14	5 28 3 37
1775	20 1 30 35	8 29 46 13	8 10 29 20	7 6 46 38
1776	8 10 19 12	8 19 2 5	6 20 17 25	7 14 49 25
1777	27 7 51 51	9 7 24 17	5 25 54 31	8 23 32 26
1778	16 16 40 28	8 26 40 9	4 5 42 36	9 1 35 13
1779	6 1 29 4	8 15 56 1	2 15 30 41	9 9 38 0
1780	23 23 1 44	8 4 18 13	1 21 7 47	10 18 21 1
1781	13 7 50 21	8 23 34 5	0 0 55 52	10 26 23 48
1782	2 16 38 57	8 12 49 58	10 10 43 57	11 4 26 35
1783	21 14 11 37	9 1 12 10	9 16 21 3	0 13 9 36
1784	9 23 0 13	8 20 28 3	7 26 9 8	0 21 12 23
1785	28 20 32 53	9 8 50 15	7 1 46 14	1 29 55 25
1786	18 5 21 30	8 28 6 7	5 11 34 19	2 7 58 12
1787	7 14 10 6	8 17 21 59	3 21 22 24	2 16 0 59
1788	25 11 42 46	9 5 44 11	2 26 59 30	3 24 44 1
1789	14 20 31 23	8 25 0 3	1 6 47 35	4 2 46 48
1790	4 5 19 59	8 14 15 55	11 16 35 40	4 10 49 35
1791	23 2 52 39	9 2 38 7	10 22 12 46	5 19 32 37
1792	11 11 41 15	8 21 53 59	9 2 0 52	5 27 35 24
1793	30 9 13 55	9 10 16 11	8 7 37 58	7 6 18 26
1794	19 18 2 32	8 29 32 3	6 17 26 4	7 14 21 13
1795	9 2 51 8	8 18 47 55	4 27 14 9	7 22 24 0
1796	27 0 23 48	9 7 10 7	4 2 51 14	9 1 7 1
1797	16 9 12 24	8 26 25 59	2 12 39 19	9 9 9 48
1798	5 18 1 1	8 15 41 51	0 22 27 25	9 17 12 35
1799	24 15 33 41	9 4 4 3	11 28 4 31	10 25 55 37
1800	13 0 22 17	8 23 19 55	10 7 52 36	11 3 58 24

TABLE II. *Mean New Moon, &c.* in March, *New Style, from* A. D. 1790 *to* A. D. 1840.

Y. of Chr.	Mean N. Moon in March.	Sun's mean Anomaly.	Moon's mean Anomaly.	Sun's mean Dif. from the Node.
	D. H. M. S.	s o ′ ″	s o ′ ″	s o ′ ″
1790	15 5 19 59	8 14 15 55	11 16 35 40	4 10 49 35
1791	4 14 8 35	8 3 31 47	9 26 23 45	4 18 52 22
1792	22 11 41 15	8 21 53 59	9 2 0 52	5 27 35 24
1793	11 20 29 51	8 11 9 51	7 11 48 57	6 5 38 11
1794	30 18 2 32	8 29 32 3	6 17 26 4	7 14 21 13
1795	20 2 51 8	8 18 47 55	4 27 14 9	7 22 24 0
1796	8 11 39 44	8 8 3 47	3 7 2 14	8 0 26 47
1797	27 9 12 24	8 26 25 59	2 12 39 19	9 9 9 48
1798	16 18 1 1	8 15 41 51	0 22 27 25	9 17 12 35
1799	6 2 49 37	8 4 57 43	11 2 15 30	9 25 15 22
1800	25 0 22 17	8 23 19 55	10 7 52 36	11 3 58 24
1801	14 9 10 54	8 12 35 47	8 17 40 41	11 12 1 9
1802	3 17 59 29	8 1 51 39	6 27 28 46	11 20 3 56
1803	22 15 32 10	8 20 13 52	6 3 5 51	0 28 46 57
1804	11 0 20 46	8 9 29 44	4 12 53 56	1 6 49 45
1805	29 21 53 26	8 27 51 56	3 18 31 2	2 15 32 46
1806	19 6 42 2	8 17 7 48	1 28 19 7	2 23 35 33
1807	8 15 30 39	8 6 23 40	0 8 7 12	3 8 38 21
1808	26 13 3 19	8 24 45 52	11 13 44 18	4 10 21 22
1809	15 21 51 55	8 14 1 44	9 23 32 23	4 18 24 9
1810	5 6 40 32	8 3 17 36	8 3 20 28	4 26 26 56
1811	24 4 13 12	8 21 39 48	7 8 57 34	6 5 9 58
1812	12 13 1 48	8 10 55 40	5 18 45 39	6 13 12 45
1813	1 21 50 24	8 0 11 32	3 28 33 44	6 21 15 32
1814	20 19 23 5	8 18 33 44	3 4 10 50	7 29 58 33
1815	10 4 11 41	8 7 49 36	1 13 58 55	8 8 1 20
1816	28 1 44 21	8 26 11 48	0 19 36 1	9 16 44 21
1817	17 10 32 57	8 15 27 40	10 29 24 6	9 24 47 8
1818	6 19 21 33	8 4 43 32	9 9 12 11	10 2 49 55
1819	25 16 54 14	8 23 5 44	8 14 49 17	11 11 32 55
1820	14 21 42 50	8 12 21 37	6 24 37 22	11 19 35 43
1821	3 10 31 26	8 1 37 29	5 4 25 27	11 27 38 30
1822	22 8 4 6	8 19 59 42	4 10 2 33	1 6 21 31
1823	11 16 52 43	8 9 15 34	2 19 50 38	1 14 24 18
1824	29 14 25 23	8 27 37 46	1 25 27 44	2 23 7 20
1825	18 23 13 59	8 16 53 38	0 5 15 49	3 1 10 7
1826	8 8 2 35	8 6 9 30	10 15 3 54	3 9 12 54
1827	27 5 35 16	8 24 31 42	9 20 41 0	4 17 55 56
1828	15 14 23 52	8 13 47 34	8 0 29 5	4 25 58 43
1829	4 23 12 28	8 3 3 26	6 10 17 10	5 4 1 30
1830	23 20 45 8	8 21 25 38	5 15 54 17	6 12 44 32
1831	13 5 33 44	8 10 41 30	3 25 42 22	6 20 47 19
1832	31 3 6 25	8 29 3 42	3 1 19 29	7 29 30 21
1833	20 11 55 1	8 18 19 34	1 11 7 34	8 7 33 8
1834	9 20 43 37	8 7 35 26	11 20 55 39	8 15 35 55
1835	28 18 16 17	8 25 57 38	10 26 32 44	9 24 18 56
1836	17 3 4 54	8 15 13 30	9 6 20 50	10 2 21 43
1837	6 11 53 30	8 4 29 22	7 16 8 55	10 10 24 30
1838	25 9 26 10	8 22 51 34	6 21 46 1	11 19 7 32
1839	14 18 14 46	8 12 7 26	5 1 34 6	11 27 10 18
1840	3 3 3 22	8 1 23 19	3 11 22 11	0 5 13 5

TABLE III. *Mean Anomalies, and Sun's mean Diſtance from the Node for* 13½ *mean Lunations.*

N	Mean Lunations. D. H. M. S.	Sun's mean Anomaly. s o ′ ″	Moon's mean Anomaly. s o ′ ″	Sun's mean Dif from the Node. s o ′ ″
1	29 12 44 3	0 29 6 19	0 25 49 0	1 0 40 14
2	59 1 28 6	1 28 12 39	1 21 38 1	2 1 20 28
3	88 14 12 9	2 27 18 58	2 17 27 1	3 2 0 42
4	118 2 56 12	3 26 25 17	3 13 16 2	4 2 40 56
5	147 15 40 15	4 25 31 37	4 9 5 2	5 3 21 10
6	177 4 24 18	5 24 37 56	5 4 54 3	6 4 1 24
7	206 17 8 21	6 23 44 15	6 0 43 3	7 4 41 38
8	236 5 52 24	7 22 50 35	6 26 32 3	8 5 21 52
9	265 18 36 27	8 21 56 54	7 22 21 4	9 6 2 6
10	295 7 20 30	9 21 3 14	8 18 10 4	10 6 42 20
11	324 20 4 32	10 20 9 33	9 13 59 5	11 7 22 34
12	354 8 48 36	11 19 15 52	10 9 48 5	0 8 2 47
13	383 21 32 40	0 18 22 12	11 5 37 6	1 8 43 1
÷	14 18 22 2	0 14 33 10	6 12 54 20	0 15 20 7

TABLE IV. *The Days of the Year, reckoned from the beginning of* March.

Days.	March.	April.	May.	June.	July.	Auguſt.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
1	1	32	62	93	123	154	185	215	246	276	307	338
2	2	33	63	94	124	155	186	216	247	277	308	339
3	3	34	64	95	125	156	187	217	248	278	309	340
4	4	35	65	96	126	157	188	218	249	279	310	341
5	5	36	66	97	127	158	189	219	250	280	311	342
6	6	37	67	98	128	159	190	220	251	281	312	343
7	7	38	68	99	129	160	191	221	252	282	313	344
8	8	39	69	100	130	161	192	222	253	283	314	345
9	9	40	70	101	131	162	193	223	254	284	315	346
10	10	41	71	102	132	163	194	224	255	285	316	347
11	11	42	72	103	133	164	195	225	256	286	317	348
12	12	43	73	104	134	165	196	226	257	287	318	349
13	13	44	74	105	135	166	197	227	258	288	319	350
14	14	45	75	106	136	167	198	228	259	289	320	351
15	15	46	76	107	137	168	199	229	260	290	321	352
16	16	47	77	108	138	169	200	230	261	291	322	353
17	17	48	78	109	139	170	201	231	262	292	323	354
18	18	49	79	110	140	171	202	232	263	293	324	355
19	19	50	80	111	141	172	203	233	264	294	325	356
20	20	51	81	112	142	173	204	234	265	295	326	357
21	21	52	82	113	143	174	205	235	266	296	327	358
22	22	53	83	114	144	175	206	236	267	297	328	359
23	23	54	84	115	145	176	207	237	268	298	329	360
24	24	55	85	116	146	177	208	238	269	299	330	361
25	25	56	86	117	147	178	209	239	270	300	331	362
26	26	57	87	118	148	179	210	240	271	301	332	363
27	27	58	88	119	149	180	211	241	272	302	333	364
28	28	59	89	120	150	181	212	242	273	303	334	365
29	29	60	90	121	151	182	213	243	274	304	335	366
30	30	61	91	122	152	183	214	244	275	305	336	
31	31		92		153	184		245		306	337	

Fig. 203

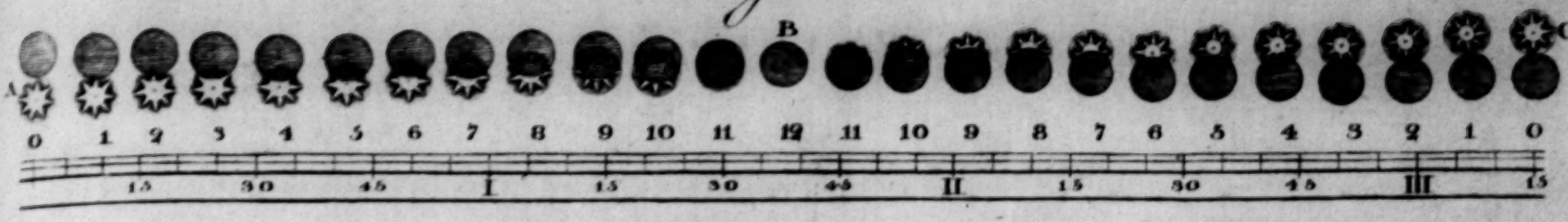

Fig. 204

Northern Hemisphere with the Figures of the Constellations

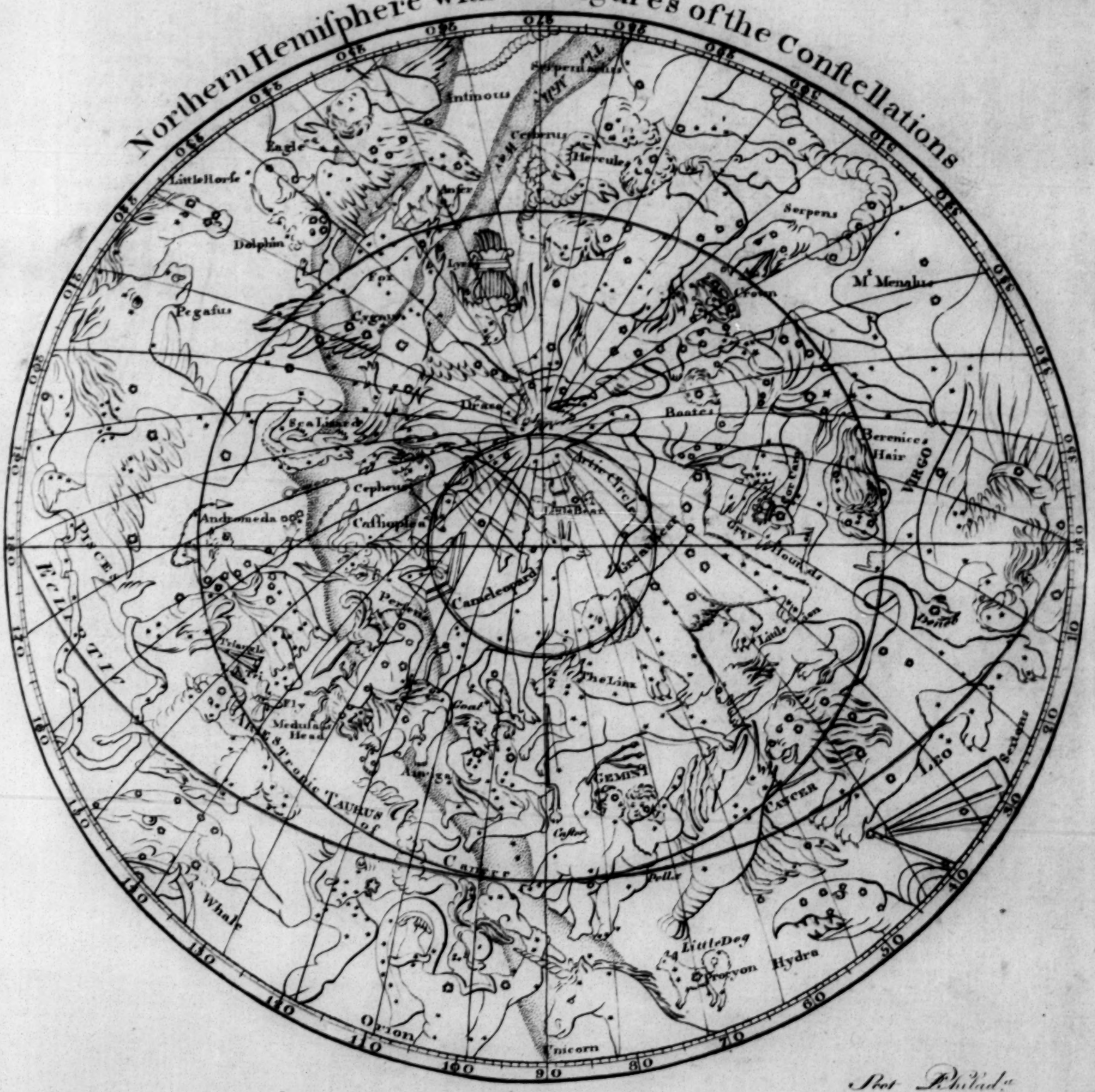

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TABLE V. *Mean Lunations from* 1 *to* 100000.

Lunat.	Days. Decimal Parts.	Days. Hou. M. S. Th. Fo.
1	29.530590851080 =	29 12 44 3 2 58
2	59.061181702160	59 1 28 6 5 57
3	88.591772553240	88 14 12 9 8 55
4	118.122363404320	118 2 56 12 11 53
5	147.652954255401	147 15 40 15 14 52
6	177.183545106481	177 4 24 18 17 50
7	206.714135957561	206 17 8 21 20 48
8	236.244726808641	236 5 52 24 23 47
9	265.775317659722	265 18 36 27 26 45
10	295.305908510800	295 7 20 30 29 43
20	590.611817021600	590 14 41 0 59 26
30	885.917725532400	885 22 1 31 29 10
40	1181.223634043200	1181 5 22 1 58 53
50	1476.529542554001	1476 12 42 32 28 36
60	1771.835451064801	1771 20 3 2 58 19
70	2067.141359575601	2067 3 23 33 28 2
80	2362.447268086401	2362 10 44 3 57 46
90	2657.753176597201	2657 18 4 34 27 29
100	2953.059085108000	2953 1 25 4 57 12
200	5906.118170216000	5906 2 50 9 54 24
300	8859.177255324000	8859 4 15 14 51 36
400	11812.236340432000	11812 5 40 19 48 48
500	14765.295425540001	14765 7 5 24 46 0
600	17718.354510648001	17718 8 30 29 43 12
700	20671.413595756101	20671 9 55 34 40 24
800	23624.472680864101	23624 11 20 39 37 36
900	26577.531765972201	26577 12 45 44 34 48
1000	29530.590851080000	29530 14 10 49 32 0
2000	59061.181702160000	59061 4 21 39 4 0
3000	88591.772553240000	88591 18 32 28 36 0
4000	118122.363404320000	118122 8 43 18 8 0
5000	147652.954255400100	147652 22 54 7 40 0
6000	177183.545106480100	177183 13 4 57 12 0
7000	206714.135957560100	206714 3 15 46 44 0
8000	236244.726808640100	236244 17 26 36 16 0
9000	265775.317659720100	265775 7 37 25 48 0
10000	295305.908510800100	295305 21 48 15 20 0
20000	590611.817021600100	590611 19 36 30 40 0
30000	885917.725532400100	885917 17 24 46 0 0
40000	1181223.634043200100	1181223 15 13 1 20 0
50000	1476529.542554001000	1476529 13 1 16 40 0
60000	1771835.451064801000	1771835 10 49 32 0 0
70000	2067141.359575601000	2067141 8 37 47 20 0
80000	2362447.268086410000	2362447 6 25 2 40 0
90000	2657753.176597220000	2657753 4 14 18 0 0
100000	2953059.085108000000	2953059 2 2 33 20 0

TABLE VI. *The first mean New Moon, with the mean Anomalies of the Sun and Moon, and the Sun's mean Distance from the Ascending Node, next after complete Centuries of Julian years.*

Lunations	Julian Years.	First New Moon. D. H. M. S.	Sun's Mean Anomaly. s o ′	M.'s mean Anomaly. s o ′	Sun from Node. s o ′
1237	100	4 8 10 52	0 3 21	8 15 22	4 19 27
2474	200	8 16 21 44	0 6 42	5 0 44	9 8 55
3711	300	13 0 32 37	0 10 3	1 16 6	1 28 22
4948	400	17 8 43 29	0 13 24	10 1 28	6 17 49
6185	500	21 16 54 21	0 16 46	6 16 50	11 7 16
7422	600	26 1 5 14	0 20 7	3 2 12	3 26 44
8659	700	0 20 32 3	11 24 22	10 21 45	7 15 31
9895	800	5 4 42 55	11 27 43	7 7 7	0 4 58

Lunations.	Julian Years.	First New Moon. D. H. M. S.	Sun's mean Anomaly. s o ′ ″	M's mean Anomaly. s o ′ ″	Sun from Node. s o ′ ″
11132	900	9 12 53 47	0 1 4	3 22 29	4 24 25
12369	1000	13 21 4 40	0 4 25	0 7 51	9 13 53
13606	1100	18 5 15 32	0 7 46	8 23 13	2 3 20
14843	1200	22 13 26 24	0 11 7	5 8 35	6 22 47
16080	1300	26 11 37 16	0 14 28	1 23 57	11 12 15
17316	1400	1 17 4 6	11 18 43	9 13 30	3 1 2
18553	1500	6 1 14 58	11 22 4	5 28 52	7 20 29
19790	1600	10 9 25 50	11 25 25	2 14 14	0 9 56
21027	1700	14 17 36 42	11 28 46	10 29 36	4 29 23
22264	1800	19 1 47 35	0 2 8	7 14 58	9 18 51
23501	1900	23 9 58 27	0 5 29	4 0 20	2 8 18
24738	2000	27 18 9 19	0 8 50	0 15 42	6 27 45
25974	2100	2 13 36 8	11 13 5	8 5 15	10 16 32
27211	2200	6 21 47 1	11 16 26	4 20 37	3 6 0
28448	2300	11 5 57 53	11 19 47	1 5 59	7 25 27
29685	2400	15 14 8 45	11 23 8	9 21 21	0 14 54
30922	2500	19 22 19 38	11 26 29	6 6 43	5 4 22
32159	2600	24 6 30 30	11 29 50	2 22 4	9 23 49
33396	2700	28 14 41 22	0 3 11	11 7 26	2 13 16
34632	2800	3 10 8 11	11 7 26	6 26 59	6 2 3
35869	2900	7 18 19 3	11 10 47	3 12 21	10 21 30
37106	3000	12 2 29 56	11 14 8	11 27 43	3 10 58
38343	3100	16 10 40 48	11 17 30	8 13 5	8 0 25
39580	3200	20 18 51 40	11 20 51	4 28 27	0 19 52
40817	3300	25 3 2 33	11 24 12	1 13 49	5 9 20
42054	3400	29 11 13 25	11 27 33	9 29 11	9 28 47
43290	3500	4 6 40 14	11 1 48	5 18 44	1 17 34
44527	3600	8 14 51 6	11 5 9	2 4 6	6 7 1
45764	3700	12 23 1 59	11 8 30	10 19 28	10 26 29
47001	3800	17 7 12 51	11 11 51	7 4 50	3 15 56
48238	3900	21 15 23 43	11 15 12	3 20 12	8 5 23
49475	4000	25 23 34 35	11 18 33	0 5 34	0 24 50
50711	4100	0 19 1 25	10 22 48	7 25 7	4 13 37
51948	4200	5 3 12 17	10 26 9	4 10 29	9 3 5
53185	4300	9 11 23 9	10 29 31	0 25 51	1 22 32
54422	4400	13 19 34 1	11 2 52	9 11 13	6 11 59
55659	4500	18 3 44 54	11 6 13	5 26 35	11 1 27
56896	4600	22 11 55 46	11 9 34	2 11 57	3 20 54
58133	4700	26 20 6 38	11 12 55	10 27 19	8 10 21
59369	4800	1 15 33 27	10 17 9	6 16 52	11 29 8
60606	4900	5 23 44 20	10 20 31	3 2 14	4 18 36
61842	5000	10 7 55 12	10 23 52	11 17 36	9 8 3
63080	5100	14 16 6 4	10 27 13	8 2 58	1 27 30
64217	5200	19 0 16 56	11 0 34	4 18 20	6 16 57
65554	5300	23 8 27 49	11 3 55	1 3 42	11 6 25
65791	5400	27 16 38 41	11 7 16	9 19 4	2 25 52
68028	5500	2 12 5 30	10 11 31	5 8 37	7 14 39
69265	5600	6 20 16 22	10 14 52	1 23 59	0 4 6
70502	5700	11 4 27 15	10 18 14	10 9 21	4 23 34
71739	5800	15 12 38 7	10 21 35	6 24 43	9 13 1
72976	5900	19 20 48 59	10 24 56	3 10 5	2 2 28
74212	6000	24 4 59 52	10 28 17	11 25 27	6 21 56

TABLE VII. *The annual, or first Equation of the mean to the true Syzygy.*

Argument. Sun's mean Anomaly.

Subtract.

Degrees	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Degrees
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	
0	0 0 0	2 3 12	3 35 0	4 10 53	3 39 30	2 7 45	30
1	0 4 18	2 6 55	3 37 10	4 10 57	3 37 19	2 3 55	29
2	0 8 35	2 10 36	3 39 18	4 10 55	3 35 6	2 0 1	28
3	0 12 51	2 14 15	3 41 23	4 10 49	3 32 50	1 56 5	27
4	0 17 8	2 17 52	3 43 26	4 10 39	3 30 30	1 52 6	26
5	0 21 24	2 21 27	3 45 25	4 10 24	3 28 5	1 48 4	25
6	0 25 39	2 25 9	3 47 19	4 10 4	3 25 35	1 41 1	24
7	0 28 55	2 28 29	3 49 7	4 9 39	3 23 0	1 39 56	23
8	0 34 11	2 31 57	3 50 50	4 9 10	3 20 20	1 35 49	22
9	0 38 26	2 35 22	3 52 29	4 8 37	3 17 35	1 31 41	21
10	0 42 39	2 38 44	3 54 4	4 7 59	3 14 49	1 27 31	20
11	0 46 52	2 42 3	3 55 35	4 7 16	3 11 59	1 23 19	19
12	0 51 4	2 45 18	3 57 2	4 6 29	3 9 6	1 19 5	18
13	0 55 17	2 48 30	3 58 27	4 5 37	3 6 10	1 14 49	17
14	0 59 27	2 51 40	3 59 49	4 4 41	3 3 10	1 10 32	16
15	1 3 36	2 54 48	3 1 7	4 3 40	3 0 7	1 6 15	15
16	1 7 45	2 57 53	4 2 18	4 2 35	2 57 0	1 1 56	14
17	1 11 53	3 0 54	4 3 23	4 1 26	2 53 49	0 57 36	13
18	1 16 0	3 3 51	4 4 22	4 0 12	2 50 36	0 53 15	12
19	1 20 6	3 6 45	4 5 18	3 58 52	2 47 18	0 48 52	11
20	1 24 10	3 9 36	4 6 10	3 57 27	2 43 57	0 44 28	10
21	1 28 12	3 12 24	4 6 58	3 55 59	2 40 33	0 40 2	9
22	1 32 12	3 15 9	4 7 41	3 54 26	2 37 6	0 35 36	8
23	1 36 10	3 17 51	4 8 21	3 52 49	2 33 35	0 31 10	7
24	1 40 6	3 20 30	4 8 57	3 51 9	2 30 2	0 26 44	6
25	1 44 1	3 23 5	4 9 29	3 49 26	2 26 26	0 22 17	5
26	1 47 54	3 25 36	4 9 55	3 47 38	2 22 47	0 17 50	4
27	1 51 46	3 28 3	4 10 16	3 45 44	2 19 5	0 13 23	3
28	1 55 37	3 30 26	4 10 33	3 43 45	2 15 20	0 8 56	2
29	1 59 26	3 32 45	4 10 45	3 41 40	2 11 35	0 4 29	1
30	2 3 12	3 35 0	4 10 53	3 39 30	2 7 45	0 0 0	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE VIII. *Equation of the Moon's mean Anomaly.*

Argument. Sun's mean Anomaly.

Subtract.

Degrees	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Degrees
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	0 0 0	0 46 45	1 21 32	1 35 1	1 23 4	0 48 19	30
1	0 1 37	0 48 10	1 22 21	1 35 2	1 22 14	0 46 51	29
2	0 3 13	0 49 34	1 23 10	1 35 1	1 21 24	0 45 23	28
3	0 4 52	0 50 53	1 23 57	1 35 0	1 20 32	0 43 54	27
4	0 6 28	0 52 19	1 24 41	1 34 57	1 19 38	0 42 24	26
5	0 8 6	0 53 40	1 25 24	1 34 50	1 18 42	0 40 53	25
6	0 9 42	0 55 0	1 26 6	1 34 43	1 17 45	0 39 21	24
7	0 11 20	0 56 21	1 26 42	1 34 33	1 16 48	0 37 49	23
8	0 12 56	0 57 38	1 27 28	1 34 22	1 15 47	0 36 15	22
9	0 14 33	0 58 56	1 28 6	1 34 9	1 14 44	0 34 40	21
10	0 16 10	1 0 13	1 28 43	1 33 53	1 13 41	0 33 5	20
11	0 17 47	1 1 29	1 29 17	1 33 37	1 12 37	0 31 31	19
12	0 19 23	1 2 43	1 29 51	1 33 20	1 11 33	0 29 54	18
13	0 20 59	1 3 56	1 30 22	1 33 0	1 10 26	0 28 18	17
14	0 22 35	1 5 8	1 30 50	1 32 38	1 9 17	0 26 40	16
15	0 24 10	1 6 18	1 31 19	1 32 14	1 8 8	0 25 3	15
16	0 25 45	1 7 27	1 31 45	1 31 50	1 6 58	0 23 23	14
17	0 27 19	1 8 36	1 32 12	1 31 23	1 5 46	0 21 45	13
18	0 28 52	1 9 42	1 32 34	1 30 55	1 4 32	0 20 7	12
19	0 30 25	1 10 49	1 32 57	1 30 25	1 3 19	0 18 28	11
20	0 31 57	1 11 54	1 33 17	1 29 54	1 2 1	0 16 48	10
21	0 33 29	1 12 58	1 33 36	1 29 20	1 0 45	0 15 8	9
22	0 35 2	1 14 1	1 33 52	1 28 45	0 59 26	0 13 28	8
23	0 36 32	1 15 1	1 34 6	1 28 9	0 58 7	0 11 48	7
24	0 38 1	1 16 0	1 34 18	1 27 30	0 56 45	0 10 7	6
25	0 39 29	1 16 59	1 34 30	1 26 50	0 55 23	0 8 20	5
26	0 40 59	1 17 57	1 34 40	1 26 27	0 54 1	0 6 44	4
27	0 42 26	1 18 52	1 34 48	1 25 5	0 52 37	0 5 3	3
28	0 43 54	1 19 47	1 34 54	1 24 39	0 51 12	0 3 21	2
29	0 45 19	1 20 40	1 34 58	1 23 52	0 49 45	0 1 40	1
30	0 46 45	1 21 32	1 35 1	1 23 4	0 48 19	0 0 0	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

TAB. IX. *The second Equation of the mean to the true Sizygy.*

Argument. Moon's equated Anomaly.

Add

Degrees	0 Signs	1 Sign	2 Sign	3 Signs	4 Signs	5 Signs	Degrees
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	
0	0 0 0	5 12 48	8 47 8	9 46 44	8 8 59	4 34 33	30
1	0 10 58	5 21 56	8 51 45	9 45 3	8 3 12	4 26 1	29
2	0 21 56	5 30 57	8 56 10	9 45 12	7 57 23	4 17 25	28
3	0 32 54	5 39 51	9 0 25	9 44 11	7 51 33	4 8 47	27
4	0 43 52	5 48 37	9 4 31	9 42 59	7 45 46	4 0 7	26
5	0 54 50	5 57 17	9 8 25	9 41 36	7 39 46	3 51 23	25
6	1 5 48	6 5 51	9 12 9	9 40 3	7 33 36	3 42 32	24
7	1 16 46	6 14 19	9 15 43	9 38 19	7 27 22	3 33 38	23
8	1 27 44	6 22 41	9 19 5	9 36 24	7 21 2	3 24 42	22
9	1 38 40	6 30 57	9 22 14	9 34 18	7 14 30	3 15 44	21
10	1 49 33	6 39 4	9 25 12	9 32 1	7 7 50	3 6 45	20
11	2 0 23	6 47 0	9 27 54	9 29 33	7 1 2	2 57 43	19
12	2 11 10	6 54 46	9 30 32	9 26 54	6 54 8	2 48 39	18
13	2 21 54	7 2 24	9 32 58	9 24 4	6 47 9	2 39 34	17
14	2 32 34	7 9 52	9 35 12	9 21 3	6 40 6	2 30 28	16
15	2 43 9	7 17 9	9 37 14	9 17 51	6 32 56	2 21 19	15

TABLE IX. *Concluded.*

Degrees	0 Signs			1 Sign			2 Signs			3 Signs			4 Signs			5 Signs			Degrees
	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	
0	0	0	0	5	12	48	8	47	8	9	46	44	8	8	59	4	34	33	30
1	0	2	53	38	7	24	19	9	39	8	9	14	28	6	25	40	2	12	8	14
1	7	3	4	3	7	31	18	9	40	51	9	10	54	6	18	18	2	2	53	13
1	8	3	14	24	7	38	9	9	42	21	9	7	9	6	10	49	1	53	36	12
1	9	3	24	42	7	44	51	9	43	42	9	3	13	6	3	16	1	44	16	11
2	0	3	34	58	7	51	24	9	44	53	8	59	6	5	55	38	1	34	54	10
2	1	3	45	11	7	57	45	9	45	52	8	54	50	5	47	54	1	25	31	9
2	2	3	55	21	8	3	56	9	46	38	8	50	24	5	40	4	1	16	7	8
2	3	4	5	26	8	9	57	9	47	13	8	45	48	5	32	9	1	6	41	7
2	4	4	15	26	8	15	46	9	47	36	8	41	2	5	24	9	0	57	13	6
2	5	4	25	20	8	21	24	9	47	49	8	36	6	5	16	50	0	47	44	5
2	6	4	35	6	8	26	52	9	47	54	8	31	0	5	7	56	0	38	13	4
2	7	4	44	42	8	32	11	9	47	46	8	25	44	4	59	42	0	28	41	3
2	8	4	54	11	8	37	19	9	47	33	8	20	18	4	51	15	0	19	8	2
2	9	5	3	33	8	42	18	9	47	14	8	14	33	4	43	2	0	9	34	1
3	0	5	12	48	8	47	8	9	46	44	8	8	59	4	34	33	0	0	0	0
Deg.	11 Signs			10 Signs			9 Signs			8 Signs			7 Signs			6 Signs			Deg.

TAB. X. *The third equation of the mean to the true Syzygy.*

Argument. Sun's Anomaly.—Moon's Anomaly.

Degrees	0 Signs Sub. 6 Add		1 Sign Sub. 7 Add		2 Signs Sub. 8 Add		Degrees
	M.	S.	M.	S.	M.	S.	
0	0	0	2	22	4	12	30
1	0	5	2	26	4	15	29
2	0	10	2	30	4	18	28
3	0	15	2	34	4	21	27
4	0	20	2	38	4	24	26
5	0	25	2	42	4	27	25
6	0	30	2	46	4	30	24
7	0	35	2	50	4	32	23
8	0	40	2	54	4	34	22
9	0	45	2	58	4	36	21
10	0	50	3	2	4	38	20
11	0	55	3	6	4	40	19
12	1	0	3	10	4	42	18
13	1	5	3	14	4	44	17
14	1	10	3	18	4	46	16
15	1	15	3	22	4	48	15
16	1	20	3	26	4	50	14
17	1	25	3	30	4	51	13
18	1	30	3	34	4	52	12
19	1	35	3	38	4	53	11
20	1	40	3	42	4	54	10
21	1	45	3	45	4	55	9
22	1	49	3	48	4	56	8
23	1	52	3	51	4	57	7
24	1	56	3	54	4	57	6
25	2	0	3	57	4	57	5
26	2	4	4	0	4	58	4
27	2	9	4	3	4	58	3
28	2	13	4	6	4	58	2
29	2	18	4	9	4	58	1
30	2	22	4	12	4	58	0
Degrees	5 Signs Sub. 11 Add		4 Signs Sub. 10 Add		3 Signs Sub. 9 Add		Degrees

TAB. XI. *The fourth equation of the mean to the true Syzygy.*

Argument Sun's mean distance from the Node.

Add

Degrees	0 6 } Sig.	M.	S.	1 7 } Sig.	M.	S.	2 8 } Sig.	M.	S.	Degrees
0		0	0		1	22		1	22	30
1		0	4		1	23		1	21	29
2		0	7		1	24		1	20	28
3		0	10		1	25		1	18	27
4		0	13		1	26		1	16	26
5		0	16		1	27		1	14	25
6		0	20		1	28		1	12	24
7		0	23		1	29		1	10	23
8		0	26		1	30		1	8	22
9		0	29		1	31		1	6	21
10		0	32		1	32		1	3	20
11		0	35		1	33		1	0	19
12		0	38		1	33		0	57	18
13		0	41		1	34		0	54	17
14		0	44		1	34		0	51	16
15		0	47		1	34		0	49	15
16		0	50		1	34		0	45	14
17		0	52		1	34		0	41	13
18		0	54		1	34		0	37	12
19		0	57		1	33		0	34	11
20		1	0		1	33		0	31	10
21		1	2		1	32		0	28	9
22		1	5		1	31		0	25	8
23		1	8		1	30		0	22	7
24		1	10		1	29		0	19	6
25		1	12		1	28		0	16	5
26		1	14		1	27		0	13	4
27		1	16		1	26		0	10	3
28		1	18		1	25		0	6	2
29		1	20		1	24		0	3	1
30		1	22		1	22		0	0	0
Deg.	5 11 } Sig			4 10 } Sig			3 9 } Sig.			Deg.

Subtract

TABLE XII. *The Sun's mean Longitude, Motion, and Anomaly: Old Style.*

Years beginning	Sun's mean Longitude. s	o	′	″	Sun's mean Anomaly. s	o	′
1	9	7	53	10	6	28	48
201	9	9	23	50	6	26	57
301	9	10	9	10	6	26	1
401	9	10	54	30	6	25	5
501	9	11	39	50	6	24	9
1001	9	15	26	30	6	19	32
1101	9	16	11	50	6	18	36
1201	9	16	57	10	6	17	40
1301	9	17	42	30	6	16	44
1401	9	18	27	50	6	15	49
1501	9	19	13	10	6	14	53
1601	9	19	58	30	6	13	57
1701	9	20	43	50	6	13	1
1801	9	21	29	10	6	12	6

Years complete	Sun's mean Motion. s	o	′	″	Sun's mean Anomaly. s	o	′
1	11	29	45	40	11	29	45
2	11	29	31	20	11	29	29
3	11	29	17	0	11	29	14
4	0	0	1	49	11	29	58
5	11	29	47	29	11	29	42
6	11	29	33	9	11	29	27
7	11	29	18	49	11	29	11
8	0	0	3	38	11	29	55
9	11	29	49	18	11	29	40
10	11	29	34	58	11	29	24
11	11	29	20	38	11	29	9
12	0	0	5	26	11	29	53
13	11	29	51	7	11	29	37
14	11	29	36	47	11	29	22
15	11	29	22	27	11	29	7
16	0	0	7	15	11	29	50
17	11	29	52	55	11	29	35
18	11	29	38	35	11	29	20

Years complete	Sun's mean Motion. s	o	′	″	Sun's mean Anomaly. s	o	′
19	11	29	24	16	11	29	4
20	0	0	9	4	11	29	48
40	0	0	18	8	11	29	37
60	0	0	27	12	11	29	26
80	0	0	36	16	11	29	15
100	0	0	45	20	11	29	4
200	0	1	30	40	11	28	8
300	0	2	16	0	11	27	12
400	0	3	1	20	11	26	16
500	0	3	46	40	11	25	21
600	0	4	32	0	11	24	25
700	0	5	17	20	11	23	29
800	0	6	2	40	11	22	33
900	0	6	48	0	11	21	37
1000	0	7	33	20	11	20	41
2000	0	15	6	40	11	11	22
3000	0	22	40	0	11	2	3
4000	1	0	13	20	10	22	44
5000	1	7	46	40	10	13	25
6000	1	15	20	0	10	4	6

Months	Sun's mean Motion. s	o	′	″	Sun's mean Anomaly. s	o	′
Jan.	0	0	0	0	0	0	0
Feb.	1	0	33	18	1	0	33
Mar.	1	28	9	11	1	28	9
Apr.	2	28	42	30	2	28	42
May	3	28	16	40	3	28	17
June	4	28	49	58	4	28	50
July	5	28	24	8	5	28	24
Aug.	6	28	57	26	6	28	57
Sept.	7	29	30	44	7	29	30
Oct.	8	29	4	54	8	29	4
Nov.	9	29	38	12	9	29	37
Dec.	10	29	12	22	10	29	11

Days	Sun's mean Motion and Anomaly. s	o	′	″	Sun's mean Motion and Anomaly. H M S	o ′ ″ ‴	Sun's mean dist. from the Node. o ′ ″ , ″ ‴	Sun's mean Motion and Anomaly. H M S	o ′ ″ ‴	Sun's mean dist. from the Node. o ′ ″ , ″ ‴
1	0	0	59	8						
2	0	1	58	17	1 0 2 28	0 2 36		31 1 16 23	1 20 30	
3	0	2	57	25	2 0 4 56	0 5 12		32 1 18 51	1 23 6	
4	0	3	56	33	3 0 7 24	0 7 48		33 1 21 19	1 25 42	
5	0	4	55	42	4 0 9 51	0 10 23		34 1 23 47	1 28 18	
6	0	5	54	50	5 0 12 19	0 12 59		35 1 26 15	1 30 54	
7	0	6	53	58	6 0 14 47	0 15 35		36 1 28 42	1 33 29	
8	0	7	53	7	7 0 17 15	0 18 11		37 1 31 10	1 36 5	
9	0	8	52	15	8 0 19 43	0 20 47		38 1 33 38	1 38 40	
10	0	9	51	23	9 0 22 11	0 23 23		39 1 36 6	1 41 16	
11	0	10	50	32	10 0 24 38	0 25 58		40 1 38 34	1 43 52	
12	0	11	49	40	11 0 27 6	0 28 34		41 1 41 2	1 46 28	
13	0	12	48	48	12 0 29 34	0 31 10		42 1 43 30	1 49 4	
14	0	13	47	57	13 0 32 2	0 33 45		43 1 45 57	1 51 39	
15	0	14	47	5	14 0 34 30	0 36 21		44 1 48 25	1 54 15	
16	0	15	46	13	15 0 36 58	0 38 57		45 1 50 53	1 55 51	
17	0	16	45	22	16 0 39 26	0 41 33		46 1 53 21	1 59 27	
18	0	17	44	30	17 0 41 53	0 44 8		47 1 55 49	2 2 3	
19	0	18	43	38	18 0 44 21	0 46 44		48 1 58 17	2 4 39	
20	0	19	42	47	19 0 46 49	0 49 20		49 2 0 44	2 7 13	
21	0	20	41	55	20 0 49 17	0 51 56		50 2 3 12	2 9 50	
22	0	21	41	3	21 0 51 45	0 54 32		51 2 5 40	2 12 25	
23	0	22	40	12	22 0 54 13	0 57 8		52 2 8 8	2 15 2	
24	0	23	39	20	23 0 56 40	0 59 43		53 2 10 36	2 17 38	
25	0	24	38	28	24 0 59 8	1 2 19		54 2 13 4	2 20 14	
26	0	25	37	37	25 1 1 36	1 4 55		55 2 15 32	2 22 50	
27	0	26	36	45	26 1 4 4	1 7 31		56 2 17 59	2 25 26	
28	0	27	35	53	27 1 6 32	1 10 7		57 2 20 27	2 28 2	
29	0	28	35	2	28 1 9 0	1 12 43		58 2 22 55	2 30 28	
30	0	29	34	10	29 1 11 28	1 15 19		59 2 25 23	2 33 14	
31	1	0	33	18	30 1 13 55	1 17 45		60 2 27 51	2 35 50	

In Leap-years, after February, add one day, and one day's motion.

TABLE XIII. *Equation of the Sun's centre, or the difference between his mean and true place.*

Argument. Sun's mean Anomaly.

Subtract.

Degrees	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Degrees
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	0 0 0	0 56 47	1 39 6	1 55 37	1 41 12	0 58 33	30
1	0 1 59	0 58 30	1 40 7	1 55 39	1 40 12	0 57 7	29
2	0 3 57	1 0 12	1 41 6	1 55 38	1 39 10	0 55 19	28
3	0 5 56	1 1 53	1 42 3	1 55 36	1 38 6	0 53 30	27
4	0 7 54	1 3 33	1 42 59	1 55 31	1 37 0	0 51 40	26
5	0 9 52	1 5 12	1 43 52	1 55 24	1 35 52	0 49 49	25
6	0 11 50	1 6 50	1 44 44	1 55 15	1 34 42	0 47 57	24
7	0 13 48	1 8 27	1 45 34	1 55 3	1 33 32	0 46 5	23
8	0 15 46	1 10 2	1 46 22	1 54 50	1 32 19	0 44 11	22
9	0 17 43	1 11 36	1 47 8	1 54 35	1 31 4	0 42 16	21
10	0 19 40	1 13 9	1 47 52	1 54 17	1 29 47	0 40 21	20
11	0 21 37	1 14 41	1 48 35	1 53 57	1 28 29	0 38 25	19
12	0 23 33	1 16 11	1 49 15	1 53 36	1 27 9	0 36 28	18
13	0 25 29	1 17 40	1 49 54	1 53 12	1 25 48	0 34 30	17
14	0 27 25	1 19 8	1 50 30	1 52 46	1 24 25	0 32 32	16
15	0 29 20	1 20 34	1 51 5	1 52 18	1 23 0	0 30 33	15
16	0 31 15	1 21 59	1 51 37	1 51 48	1 21 34	0 28 33	14
17	0 33 9	1 23 22	1 52 8	1 51 15	1 20 6	0 26 33	13
18	0 35 2	1 24 44	1 52 36	1 50 40	1 18 36	0 24 32	12
19	0 36 55	1 26 5	1 53 3	1 50 5	1 17 5	0 22 32	11
20	0 38 47	1 27 24	1 53 27	1 49 26	1 15 33	0 20 30	10
21	0 40 39	1 28 41	1 53 50	1 48 46	1 13 59	0 18 28	9
22	0 42 30	1 29 57	1 54 10	1 48 3	1 12 24	0 16 26	8
23	0 44 20	1 31 11	1 54 28	1 47 19	1 10 47	0 14 24	7
24	0 46 9	1 32 25	1 54 44	1 46 32	1 9 9	0 12 21	6
25	0 47 57	1 33 35	1 54 58	1 45 44	1 7 29	0 10 18	5
26	0 49 45	1 34 45	1 55 10	1 44 53	1 5 49	0 8 14	4
27	0 51 32	1 35 53	1 55 20	1 44 1	1 4 7	0 6 11	3
28	0 53 18	1 36 59	1 55 28	1 43 7	1 2 24	0 4 7	2
29	0 55 3	1 38 3	1 55 34	1 42 10	1 0 39	0 2 4	1
30	0 56 47	1 29 6	1 55 37	1 41 12	0 58 52	0 0 0	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE XIV. *The Sun's Declination.*

Argument. Sun's true place.

Degrees	Signs 0 N. 6 S.	Signs 1 N. 7 S.	Signs 2 N. 8 S.	Degrees	Degrees	Signs 0 N. 6 S.	Signs 1 N. 7 S.	Signs 2 N. 8 S.	Degrees
	° ′	° ′	° ′			° ′	° ′	° ′	
0	0 0	11 30	20 11	30	30	0 0	11 30	20 11	30
1	0 24	11 51	20 24	29	16	6 18	16 39	22 45	14
2	0 48	12 11	20 36	28	17	6 41	16 57	22 51	13
3	1 12	12 32	20 48	27	18	7 4	17 14	22 56	12
4	1 36	12 53	20 59	26	19	7 27	17 30	23 2	11
5	1 59	13 13	21 10	25	20	7 50	17 46	23 6	10
6	2 22	13 33	21 21	24	21	8 13	18 2	23 11	9
7	2 47	13 53	21 31	23	22	8 35	18 18	23 14	8
8	3 11	14 12	21 41	22	23	9 57	18 32	23 18	7
9	3 34	14 31	21 50	21	24	9 20	18 45	23 21	6
10	3 58	14 50	21 59	20	25	9 42	19 [illegible]	23 [illegible]	5
11	4 22	15 9	22 8	19	26	10 4	19 17	23 25	4
12	4 45	15 28	22 16	18	27	10 25	19 31	23 27	3
13	5 9	15 46	22 24	17	28	10 47	19 45	23 28	2
14	5 32	16 4	22 31	16	29	11 8	19 58	23 29	1
15	5 55	16 22	22 [illegible]	15	30	11 30	20 11	23 29	0
Degrees	Signs 11 S. 5 N.	Signs 10 S. 4 N.	Signs 9 S. 3 N.	Degrees	Degrees	Signs 11 S. 5 N.	Signs 10 S. 4 N.	Signs 9 S. 3 N.	Degrees

TABLE XV. *Equation of the Sun's mean Distance from the Node.*

Argument. Sun's mean Anomaly.

Subtract.

Deg.	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Deg.
	° ′	° ′	° ′	° ′	° ′	° ′	
0	0 0	1 2	1 47	2 5	1 50	1 4	30
1	0 2	1 4	1 48	2 5	1 48	1 2	29
2	0 4	1 6	1 49	2 5	1 47	1 0	28
3	0 6	1 8	1 50	2 5	1 46	0 58	27
4	0 9	1 10	1 51	2 5	1 45	0 56	26
5	0 11	1 12	1 52	2 5	1 44	0 54	25
6	0 13	1 14	1 53	2 5	1 43	0 52	24
7	0 15	1 16	1 54	2 4	1 41	0 50	23
8	0 17	1 17	1 55	2 4	1 40	0 48	22
9	0 19	1 18	1 56	2 4	1 39	0 46	21
10	0 21	1 19	1 57	2 4	1 37	0 44	20
11	0 23	1 21	1 58	2 3	1 36	0 42	19
12	0 25	1 22	1 58	2 3	1 34	0 40	18
13	0 28	1 24	1 59	2 3	1 33	0 37	17
14	0 30	1 26	2 0	2 2	1 31	0 35	16
15	0 32	1 27	2 0	2 2	1 30	0 33	15
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Deg.	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Deg.
	° ′	° ′	° ′	° ′	° ′	° ′	
0	0 0	1 2	1 47	2 5	1 50	1 4	30
16	0 34	1 28	2 1	2 1	1 28	0 31	14
17	0 36	1 30	2 1	2 1	1 27	0 29	13
18	0 38	1 31	2 2	2 0	1 25	0 27	12
19	0 40	1 34	2 2	2 0	1 24	0 24	11
20	0 42	1 35	2 3	1 59	1 23	0 22	10
21	0 44	1 36	2 3	1 59	1 21	0 20	9
22	0 46	1 37	2 4	1 58	1 19	0 18	8
23	0 48	1 39	2 4	1 57	1 17	0 16	7
24	0 50	1 40	2 4	1 56	1 15	0 13	6
25	0 52	1 41	2 4	1 55	1 13	0 11	5
26	0 54	1 43	2 5	1 54	1 11	0 9	4
27	0 56	1 44	2 5	1 53	1 9	0 7	3
27	0 58	1 45	2 5	1 52	1 8	0 5	2
29	1 0	1 46	2 5	1 51	1 6	0 3	1
30	1 2	1 47	2 5	1 50	1 5	0 2	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE XVI. *The Moon's Latitude in Eclipses.*

Arg. Moon's equated Distance from the Node.

0 Signs. *North Ascend.*

6 Signs. *South Descend.*

°	′	″	°
0	0	0	30
1	5	15	29
2	10	30	28
3	15	45	27
4	20	59	26
5	26	13	25
6	31	26	24
7	36	39	23
8	41	51	22
9	47	2	21
10	52	13	20
11	57	23	19
12	1	2	31	18
13	1	7	38	17
14	1	12	44	16
15	1	17	49	15
16	1	22	52	14
17	1	27	53	13
18	1	32	52	12
19	1	37	49	11

5 Signs. *North Descend.*

11 Signs. *South Ascend.*

This Table shows the Moon's Latitude a little beyond the utmost Limits of Eclipses.

TABLE XVII. *The Moon's horizontal Parallax, with the Semidiameters and true Horary Motions of the Sun and Moon, to every sixth degree of their mean Anomalies, the quantities for the intermediate degrees being easily proportioned by sight.*

Anomaly of Sun and Moon.	Moon's horizontal Parallax.	Sun's Semidiameter.	Moon's Semidiameter.	Moon's Horary Motion.	Sun's Horary Motion.	Anomaly of Sun and Moon.
s °	′ ″	′ ″	′ ″	′ ″	′ ″	s °
0 0	54 29	15 50	14 54	30 10	2 23	12 0
6	54 31	15 50	14 55	30 12	2 23	24
12	54 34	15 50	14 56	30 15	2 23	18
18	54 40	15 51	14 57	30 19	2 23	12
24	54 47	15 51	14 58	30 26	2 23	6
1 0	54 56	15 52	14 59	30 34	2 24	11 0
6	55 6	15 53	15 1	30 44	2 24	24
12	55 17	15 54	15 4	30 55	2 24	18
18	55 29	15 55	15 8	31 9	2 24	12
24	55 42	15 56	15 12	31 23	2 25	6
2 0	55 56	15 58	15 17	31 40	2 25	10 0
6	56 12	15 59	15 22	31 56	2 26	24
12	56 29	16 1	15 26	32 17	2 27	18
18	56 48	16 2	15 30	32 39	2 27	12
24	57 8	16 4	15 36	33 11	2 28	6
3 0	57 30	16 6	15 41	33 33	2 28	9 0
6	57 52	16 8	15 46	33 47	2 29	24
12	58 12	16 10	15 52	34 11	2 29	18
18	58 31	16 11	15 58	34 34	2 29	12
24	58 49	16 13	16 2	34 58	2 30	6
4 0	59 6	16 14	16 9	35 22	2 30	8 0
6	59 21	16 15	16 14	35 45	2 31	24
12	59 35	16 17	16 19	36 0	2 31	18
18	59 48	16 19	16 24	36 20	2 32	12
24	60 0	16 20	16 29	36 40	2 32	6
5 0	60 11	16 21	16 31	37 0	2 32	7 0
6	60 21	16 21	16 32	37 10	2 33	24
12	60 30	16 22	16 37	37 19	2 33	18
18	60 38	16 22	16 38	37 28	2 33	12
24	60 45	16 23	16 39	37 36	2 33	6
6 0	60 45	16 23	16 39	37 40	2 33	6 0

Fig. 205.

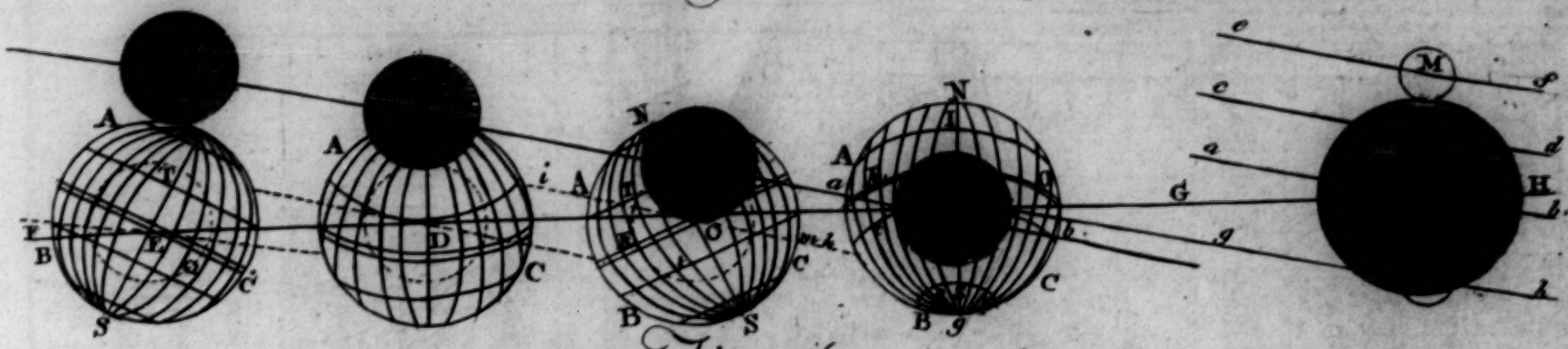
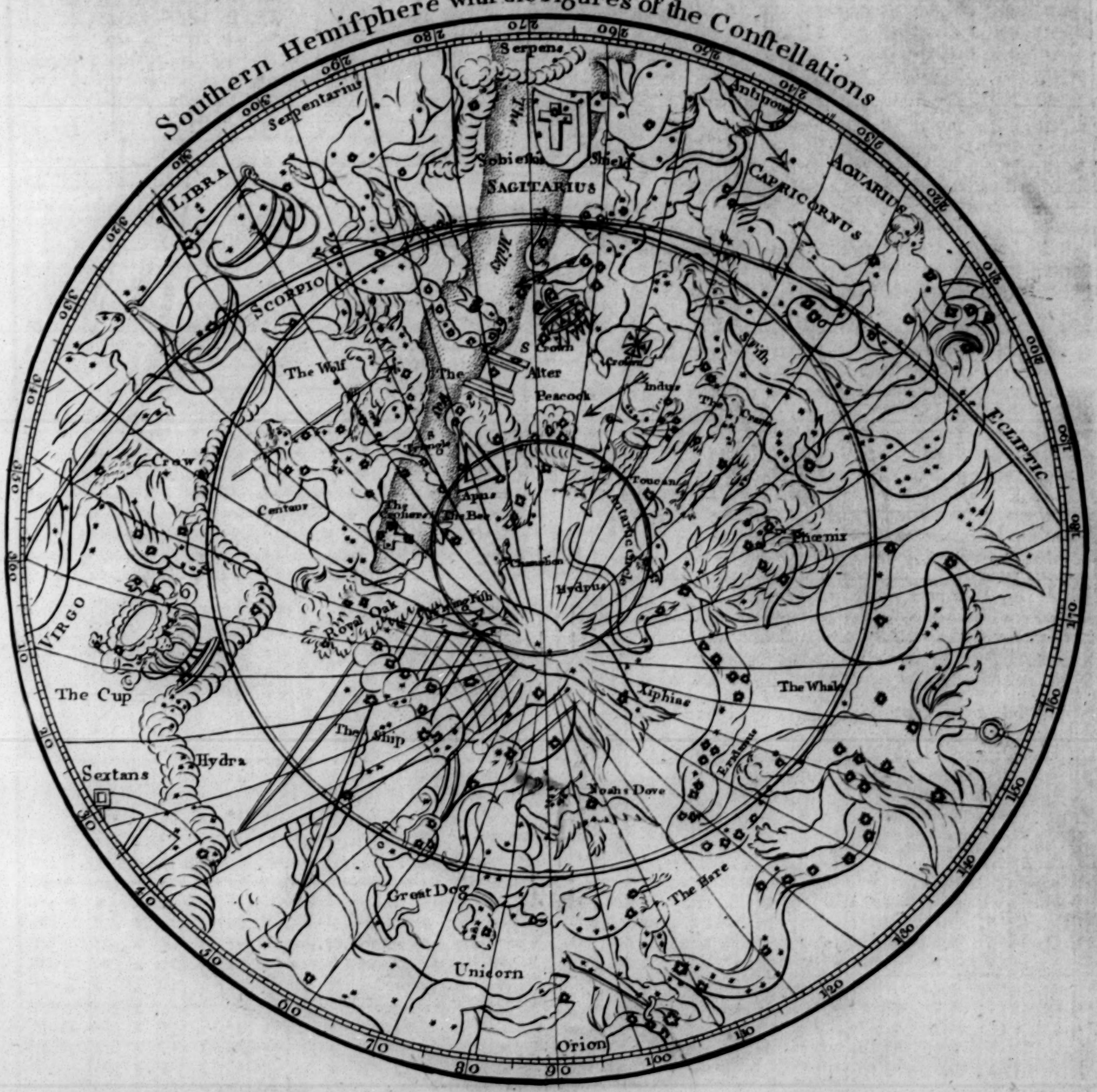


Fig. 206

Southern Hemisphere with the Figures of the Constellations



BRITISH MUSEUM

EXPLANATION AND USE OF THE SOLAR AND LUNAR TABLES.

USE *of the* TABLES *of the* EQUATION *of* TIME.

PROBLEM I.

To convert apparent time into mean time, and the contrary.

SINCE the place of the Sun's apogee does not remain fixed in the ſame point of the ecliptic, but goes forward 1′ 6″ every year, and conſequently about a degree in 55 years, the ſame equation of time will not ſerve accurately for many years continuance. To remedy this defect, we have here given two tables, one adapted to the 16th year of this century, at which time the Sun's apogee was in 8° ♋, the other to the year 1771, when the Sun's apogee was in 9° ♋. Whence the equation of time may be readily found by proportion; and that with ſufficient accuracy, not only for any intermediate year, but alſo for thoſe preceding and following, provided they are not diſtant from theſe above 60 or 100 years. The uſe of tables of this kind is ſo familiar to aſtronomers, that it ſeems unneceſſary to enter into any further explanation of theſe; we ſhall therefore only remark, that the titles of the equation or algebraic ſigns ſtanding over them are what are to be uſed for turning apparent into mean time: but the contrary are to be uſed for turning mean into apparent time.

EXAMPLE.

In the year 1756, April 30, $23^h.\ 20'.\ 28''$, apparent time, the Sun's place was obſerved $1^s.\ 11^o.\ 25'\ 8'',6$; the equation of time and the mean time are required.

With the given place of the Sun, the equation of time anſwering to the year 1716 is had = — 3′. 18″; and anſwering to the year 1771 = — 3′ 12″; and conſequently to the given year it will be = —3′ 14″; and therefore the mean time is $23^h.\ 17'.\ 14''$.

SCHOLIUM I.

But if the equation of time be required either more accurately or for a time above 100 years diſtant from the limits of the tables, the mean longitude of the Sun muſt be found reckoned from the true equinox, and his true right aſcenſion by Prob. III. and VII. which follow hereafter, and the difference between the two is to be converted into time of the *primum mobile*. And if the right aſcenſion is greater than the mean longitude, the equation ſo found is additive to apparent time, otherwiſe ſubſtractive.

SCHOLIUM II.

I ſay that the true equation of time is to be found by converting the difference abovementioned into time of the *primum mobile*, and not into mean ſolar time. For though the learned De La Caille preſcribes the latter method in his Solar Tables, yet it is eaſy to demonſtrate that the former method is the true one.

USE *of the* CATALOGUE *of* PLACES.

PROBLEM II.

To convert the time of the given place into the time of the meridian of the tables, or the contrary.

THERE is given in a ſelect catalogue the difference in time of the meridians of 60 famous places from the meridian of the tables, marked with the ſign + or —, the firſt of which denotes the place to be weſt of Greenwich, and the latter ſhews it to be eaſt of the ſame. Theſe ſigns are to be uſed if the time of the given place is to be reduced into Greenwich time; but the contrary if Greenwich time is to be reduced into time of the given place.

EXAMPLE.

Let the time at Gottingen be given $6^h.\ 9'.\ 38''$, the time that anſwers to it under the meridian of Greenwich is required?

	h	′	″
Since the difference in time of the meridians of Gottingen and Greenwich, by catalogue, is	0	39	32 —
Subtract it, on account of the ſign —, from the given time	6	9	38
The remainder is the Greenwich time required	5	30	6

SCHOLIUM I.

I deduced the differences aſcribed to the cities of France and the Netherlands from the geometrical meaſure of the French mathematicians, making allowance at the ſame time for the ſpheroidical figure of the earth. The ſituation of the cities in Germany and ſome others I ſettled with particular care from eclipſes of the Sun and occultations of fixed ſtars by the Moon. The reſt I either determined from eclipſes of Jupiter's ſatellites and eclipſes of the Moon, or, where this could not be done, retained them as they are given in the *Connoiſſance des Temps*.

SCHOLIUM II.

In the ſame catalogue are inſerted the latitudes of the places, concerning the uſe of which, as well known, it is ſuperfluous to add any thing. The latitude of Gottingen, as given in the catalogue, is that of the obſervatory of this city; the latitude of Nuremberg is adjuſted to Hoffman's houſe, famous for the ſhop of geographical maps. I deduced both, but particularly that of Gottingen, from my own obſervations. Concerning that of Nuremberg, See Com. Soc. Reg. Gotting. tom. I. p. 373.

USE *and* EXPLANATION *of the* TABLES *of the* MOTION *of the* SUN.

PROBLEM III.

To find the true longitude of the Sun at any aſſigned time by the meridian of the Greenwich obſervatory.

1. FROM the table of epoches, take out the epoches of the mean longitude of the Sun, the apogee, and the numbers I, II, III, IV, for the given year; or, if that is not there to the neareſt year that is ſet down preceding the given year; underneath which place the mean motions anſwering to the number of years elapſed ſince the epoch to the given time.

2. Under theſe write down in order the mean motions for the day of the month, and for the hours, minutes, and ſeconds.

3. Add up the numbers of the ſeveral columns, rejecting 12 S. or any multiple thereof, if they ſhould occur, from the two firſt columns, and rejecting thouſands from num. I, II, III, IV, if they ariſe. And thus the mean longitude of the Sun will be obtained to the aſſigned time in the firſt column, the longitude of the Sun's apogee in the ſecond column, and in the others the numbers proper for finding the corrections ariſing from the actions of the Moon, Jupiter, and Venus.

4. Subſtract the longitude of the apogee from the mean longitude of the Sun, the remainder is the mean anomaly of the Sun.

5. With this anomaly enter the table of the equation of the Sun's centre, and take out the equation of the Sun's centre with its proper ſign, and place it under the Sun's mean longitude.

6. With the numbers I, II, III, IV, enter the tables, and having found the hundreds at the top or bottom, and the tens on the ſide, take out the correction or leſſer equations, each with their proper number reſpectively, without neglecting the proportional part, and let theſe alſo be written under the Sun's mean longitude.

7. Apply theſe equations according to their titles or ſigns to the mean longitude; the reſult is the true longitude of the Sun required.

EXAMPLE.

If the Sun's true longitude be required to the year 1756, April 30, $23^h\ 17'.\ 14''$, mean time at Greenwich; the calculation performed according to the foregoing precepts will be as follows:

	Mean Long. ☉	Long. ☉'s apog.	N. I.	N. II.	N. III.	N. IV.
	° ′ ″	° ′ ″				
Epoch of year 1756	9.10.33.18,8	3. 8.44.10	973	262	605	544
Mean Mot. April 30th	3.28.16.39,7	22	64	301	206	18
23^h	56.40,5		32	2	2	0
17′	41,9					
14″	0,6					
Equat. of cent.	+ 1.37.54,0	Mean an. 10. 1. 2.49	69	565	813	562
Equat. ☽ I.	+ 3,4					
♀ II.	1,3					
♂ III.	0,9					
♃ IV.	6,8					
True long. of the Sun.	1.11.25. 9,9					

SCHOLIUM I.

The longitude thus found is computed from the true vernal equinoctial point, because of the equation of the equinoxes being applied, which was taken out with number IV. But, in computing the planet's and the moon's place, it is better to make use of the Sun's longitude as computed from the mean equinox, till their geocentric longitude is found; in which case therefore that equation taken out with number IV. should not be applied till then. Thus, in our example, the Sun's longitude reckoned from the mean equinox would be $1^s.\ 11^o.\ 25'.\ 16'',7$.

SCHOLIUM II.

When I was constructing these solar tables, I had in my view the tables of that learned astronomer Lewis de la Caille (who merits much commendation on this subject) published in the year 1758, and sent me as a present from him. Upon examining them I found that they very nearly agreed with the many and careful observations made by myself from the year 1756 forward with an excellent mural quadrant. Wherefore it did not seem necessary for me to construct solar tables intirely new, but only (availing myself of the labours of this illustrious astronomer) to correct his tables as far as my observations seemed to require. Accordingly I found the excentricity of the Sun's orbit, and consequently the equation of the center, to require no sensible correction. But, as to the epoches of the mean motion, particularly those of the Sun's longitude, I could not make them agree with my observations, till I had diminished the said epoch by near seven seconds. Moreover a place of the apogee somewhat different from his seemed to agree better at least with my observations, which why I should confide less in than those of others did not appear. Lastly, I had long before deduced from the theory of gravity the disturbances of the apparent motion of the Sun caused by the Moon, Jupiter and Venus, and found them such as are here represented, besides some other smaller ones, which, being extremely difficult to observe, I thought might be conveniently neglected in calculation. As to the form of the arguments of these small corrections, or numbers I, II, III, and IV, I have rendered it more simple by supposing the circle to be divided into 1000 parts.

SCHOLIUM III.

I must not pass over without mentioning in this place, that all the mean motions both of the Sun and Moon in these tables suppose the annual motion of the fixed stars or of the precession of the equinoxes to be exactly $50'',3$, and to depend thereon so much, that, if it should appear proper to state the motion of precession slower or quicker, the mean motions of the Sun must be all made slower or quicker by the same quantity: and therefore you cannot, without subverting the whole fabric of the tables, increase or diminish one of these motions and at the same time leave the rest unaltered. Thus, for instance, if the mean motion of the Sun, which I make in 60 Julian years to be $0^s.\ 0^o.\ 27'.\ 49'',8$ over and above the intire revolutions, should seem proper to be corrected so as to agree with the tables of the learned De la Caille, in which that motion is found less by $16'',4$, this cannot be done except the precession of the equinoxes in 60 years, instead of $50'.\ 18''$ as it is in the tables, be reckoned less by the same quantity or only $50'.\ 1'',6$; and so much ought the Moon's motion also to be corrected. To explain the matter briefly, I would have it observed, that the mean motions of the Sun and Moon with respect to the fixed stars are laid down truly in these tables, so that there scarce remains a doubt of a few seconds in 60 years; but whether they are also laid down justly with respect to the equinoctial points must be judged of from the motion of their precession, which being $50'.\ 18''$ in 60 years, according to the opinion of most modern astronomers, the affirmative of the question cannot be doubted.

SCHOLIUM IV.

Whenever therefore any phenomenon is concerned depending on the relative situation of a fixed star and the Sun and Moon; as for instance, the occulation of a fixed star, the motion of precession assumed in these tables must be made use of in computing the place of the star. For this purpose that motion is added to the mean motion of the Sun, that the calculator may not be left in any uncertainty, nor have any occasion to seek for it elsewhere, or lose any time in computing it.

SCHOLIUM V.

To the same tables of the mean motions of the Sun, there is also added the motion of decrease of the obliquity of the ecliptic, according to the quantity deduced from the theory of gravity. Hence the mean obliquity of the ecliptic is easily found to any time, provided it be known for any one year. Now, from my observations made with great care with an excellent mural quadrant, at both solstices, in the years 1756, 57, and 58, I find the mean obliquity of the ecliptic to the beginning of the year 1756 to be $23^o.\ 28'.\ 16''$, which therefore should be made use of in the present case.

PROBLEM IV.

To find the mean and true obliquity of the ecliptic to any assigned time.

1. From the column that lies farthest to the right hand, take out the decrease of the obliquity of the ecliptic, answering to the number of years intervening between the given time and the year 1756; which add to $23^o.\ 28'.\ 16''$, if the given time precedes 1756, but subtract, if it follows the same, and the mean obliquity

obliquity of the ecliptic will be obtained to the beginning of the year; which is eaſily reduced to the elapſed time of the given year, by ſubſtracting one tenth of a ſecond for every three months.

2. By means of the tables of epoches and mean motions, find num. IV. with which take out the equation from the table intitled Nutation, and apply it according to its ſign to the mean obliquity juſt found, and you have the true or apparent obliquity.

EXAMPLE.

What was the true obliquity of the ecliptic in the beginning of September 1671.

Becauſe from this year to the year 1756 there are elapſed 85 years, the decreaſe of the obliquity will be found for 80 years - -	36″,8
For 5 years - -	2,3
And conſequently for 85 years - - -	39,1

Which added to 23°. 28′. 16″,0 gives the mean obliquity of the ecliptic 23°. 28′ 55″,1, and in the month of September 23°. 28′. 54″,8.

Now num. IV. to the epoch 1660 is - - -	386
The motion for 11 years - -	591
For the beginning of September -	36
Therefore num. IV. to the given time, rejecting 1000, is	13

To which the correſponding correction or nutation is +9″,6, which, being added to the mean obliquity 23°. 28′. 54″,8, gives the true obliquity 23°. 29′. 4″,4.

SCHOLIUM I.

But if the mean obliquity is to be found from the true, it is evident that the nutation muſt be applied with a contrary ſign.

SCHOLIUM II.

The maximum of nutation 9″,6, according to which this table is conſtructed, exceeds a little that which is commonly aſſumed, the laws of attraction requiring ſuch increaſe, and the obſervations at the ſame time favouring it.

PROBLEM V.

To find the logarithm of the Sun's diſtance from the earth at any aſſigned time.

1. If the mean anomaly of the Sun, with the numbers I, II, III, are not already known from a calculation of the Sun's longitude, they muſt be found by prob. III. 1. 2. 3. 4.

2. With the mean anomaly take out the logarithm of the diſtance in the ecliptic hypotheſis.

3. To this apply the corrections taken with the numbers I. II. III, out of their reſpective tables, the reſult is the true logarithm of the diſtance.

EXAMPLE.

In the example of prob. III. the mean anomaly of the Sun was 10°. 1°. 2′. 49″, wherefore the uncorrected logarithm is - - - -	0.003836
Num. I. 69. gives - - - - +	15
Num. II. 565. - - - - —	8
Num. III. 813. - - - - —	5
Therefore the logarithm of the true diſtance	0.003838

SCHOLIUM.

Theſe logarithms are adapted to a mean diſtance = 1, wherefore to prevent the logarithms of numbers leſs than unity from coming out negative, their index is ſuppoſed to be increaſed by ten, which therefore muſt be again rejected, when the caſe requires it.

PROBLEM VI.

To find the apparent ſemidiameter, and alſo the hourly motion of the Sun, to any aſſigned time.

Both are readily had, if the mean anomaly of the Sun to the given time be known or firſt found by prob. III.

EXAMPLE.

In the example of prob. III. the mean anomaly of the Sun was	° ′ ″
	10. 1. 2. 49
Wherefore the apparent ſemidiameter of the Sun is	15. 54,3
And his true hourly motion - -	2. 25,2

SCHOLIUM.

The ſemidiameter of the Sun, as here given, is ſuited to the ſuppoſition of the ſemidiameter at the mean diſtance being 16′. 2″,8; which quantity I have inferred from above 130 obſervations made with the mural quadrant, which did not ſeem ill-adapted for this purpoſe.

PROBLEM VII.

The longitude of the Sun or any point of the ecliptic, and the obliquity of the ecliptic being given, to find the correſponding right aſcenſion.

1. With the given longitude look for the reduction and its mutation or change.

2. Say, as 60″ : is to this mutation : : ſo is the difference between 23°. 28′. 15″,0 and the given obliquity, to a fourth number, which added to the reduction juſt found, if the given obliquity be greater than 23°. 28′. 15″,0, or ſubſtracted from it, if the obliquity be leſs, will give the reduction corrected.

3. Therefore apply this according to its ſign to the longitude, and you will have the right aſcenſion required.

EXAMPLE.

Let the longitude of the Sun be given 1ˢ. 11°. 25′. 10″,3, and the obliquity 23°. 28′. 7″,0, the right aſcenſion is required.

With the given longitude the reduction is found	—2°. 26′. 19″,0
And its mutation - - -	12,7

Since therefore the given obliquity differs 8″ from 23°. 28′. 15″,0, ſay, as 60″ : is to 12″,7 : : ſo is 8″,0 : to a 4th number, 1″,7, which being ſubſtracted, leaves the true reduction —0°. 2° 26.′17″,3

And therefore the right aſcenſion required	1 .8 .58 .53 ,0
Or, - -	38 .58 .53 ,0

PROBLEM VIII.

The right aſcenſion of the Sun or a point of the ecliptic, and the obliquity of the ecliptic being given, to find the correſponding longitude.

1. With the right aſcenſion increaſed by three ſigns, find the proper reduction in the very ſame manner as in the preceding problem, for the given obliquity of the ecliptic, and from the ſame table.

2. Apply this according to its ſign to the given right aſcenſion, and the required longitude will be found.

EXAMPLE.

If the given obliquity be 23°. 28′. 7″,0, and the right aſcenſion 38°. 58′. 53″,0, or 1ˢ. 8°. 58′. 53″,0, adding three ſigns to this we ſhall have 4ˢ. 8°. 58′. 53″,0, and therefore by the reduction + 2°. 26′. 19″,1, with the mutation 12″,9. Then ſay, as 60″ : is to 12″,9 : : ſo is the difference of the obliquities, 8″ : to a fourth number, 1″,7, which, ſubſtracted from + 2°. 26′. 19″,1, leaves the true reduction + 2°. 26′. 17″,4; hence the longitude required is 1ˢ. 11°. 25′. 10″,4.

PROBLEM IX.

The obliquity of the ecliptic, and the longitude of the Sun or a point of the ecliptic being given, to find the correſponding declination.

1. With the given longitude find the declination with its mutation or change.

2. Say, as 60″ : is to this mutation : : ſo is the difference between 23°. 28′. 15″,0, and the given obliquity : to a fourth number, which added to or ſubſtracted from the declination juſt found, according as the given obliquity is greater or leſs than 23°. 28′. 15″,0, will give the declination required; which will be north if marked in the table with the ſign +, but ſouth if diſtinguiſhed with the ſign —.

EXAMPLE.

EXAMPLE.

Let the logitude be 1°. 11°. 25'. 10″,3, and the obliquity 23°. 28'. 7″,0, the declination is + 15°. 16'. 38″,0, and the mutation 37″,7. And as 60″ : is to 37″,7 : : ſo is 8″,0 to a fourth number, 5″,0; which, becauſe the given obliquity is leſs than 23°. 28' 15″,0, muſt be ſubſtracted from 15°. 16'. 38″,0; Hence the true declination is 15°. 16'. 33″,0 +, or north.

PROBLEM X.

The obliquity of the ecliptic and declination of the Sun being given, to find his longitude.

1. Enter the table, with the given declination, and take out the mutation anſwering to it.

2. With this mutation and the difference of the obliquities find, as in the preceding problems, a fourth number, which ſubſtract from the given declination, if the given obliquity be greater than 23°. 28'. 15″,0, or add, if it be leſs; the reſult will be the declination, ſuch as it would be if the obliquity was 23°. 28'. 15″.

3. With this declination enter the ſame table again, and by making proportion find the longitude.

EXAMPLE.

On the firſt day of May 1756, the Sun's declination was obſerved 15°. 16'. 34″,2 north, and the obliquity of the ecliptic was 23°. 28'. 7″.0, the longitude of the Sun is required.

Since this declination has the mutation 37″,7 aſcribed to it in the table: ſay, as 60″ : is to 37″,7 : : ſo is 8″ : to a fourth number, 5″,0; therefore the declination would be + 15° 16'.39″,2, if the obliquity was as great as it is ſuppoſed in the table; wherefore from the ſame table the longitude of the Sun will be found either 1s. 11°. 25'. 11″,4 or 4s. 18°. 34'. 48″,6; but ſince in the month of May the Sun is in the aſcending ſigns, the firſt only in this caſe is the true one.

PROBLEM XI.

The obliquity of the ecliptic, and the longitude or right aſcenſion of any point of the ecliptic being given, to find the angle between the ecliptic and the parallel to the equator paſſing thro' that point.

1. If it be the longitude which is given, firſt find the right aſcenſion by problem VII.

2. With the right aſcenſion ſo found, or given, and increaſed by three ſigns, find the declination by problem IX. which, only with the change of its name, will repreſent the angle between the ecliptic and the parallel. And according as the ſign is + or —, the ecliptic will aſcend above, or deſcend below the parallel.

EXAMPLE.

Let the given right aſcenſion be 38°. 58'. 53″,0, which, increaſed by three ſigns, becomes 4s. 8°. 58'. 53″,0. Hence by problem IX. for the obliquity 23°. 28'. 7″,0, there will be found 18°. 2'. 1″,4 +, wherefore ſo much the ecliptic is inclined to the parallel, and aſcends above it, or towards the north.

PROBLEM XII.

The Sun's diſtance from the zenith being given to find his parallax in a vertical circle.

This, which is alſo called the parallax in altitude, is eaſily found from its proper table, and is uſeful either for converting the obſerved diſtance from the zenith into the true, or the contrary. In the firſt caſe it is to be ſubſtracted from, and in the latter added to, the diſtance from the zenith. 2

USE *and* EXPLANATION *of the* TABLE *of* ASTRONOMICAL REFRACTIONS.

PROBLEM XIII.

The apparent diſtance of a celeſtial object from the zenith, and the temperature of the air ſhewn by the barometer and thermometer being given, to find the refraction.

IT is not the buſineſs of this place to treat largely of the nature of the aſtronomical refractions, or to explain the whole theory of them. But ſo much it ſeems proper to premiſe, that the refractions greatly depend on the viciſſitudes of the atmoſphere, and on its heat and elaſticity; and therefore it is neceſſary for obſervers, at the ſame time that they obſerve the altitude or zenith diſtance of a ſtar, to take notice alſo of the ſtate of the atmoſphere as ſhewn by the barometer and thermometer, and write it down in their journal. For ſince the modern practical aſtronomy is brought to this pitch, as to be almoſt wholly employed in ſearching out little niceties, and correcting ſmall errors, formerly overlooked, ſo neither is it proper to diſregard thoſe, which may affect obſervations from the variableneſs of the refractions. My table, which ſerves for computing the true refractions to any temperature of the air, in any part of the earth, requires the height of the barometer to be noted to twelfths of an inch or lines of the Paris foot, and the height of the thermometer according to Reaumur's ſcale: ſo that if the obſerver ſhould make uſe of a different meaſure, it muſt be firſt reduced to this before the refraction is computed†.

The firſt column of the table of refraction contains the refraction anſwering to every degree of zenith-diſtance, for that ſtate of the air, in which the height of the mercury in the barometer is 28 inch. 0 lin. and that of Reaumur's thermometer 10 degrees above the freezing point. The ſecond and third columns ſhew the variations of the refraction, the former for 10 lines of the barometer, and the latter for as many degrees of the thermometer; whence the proportioxal part is eaſily had for any other number of lines or degrees. Now the refraction is greater than the tabular one, and therefore the proportional part is to be added if the barometer is higher than 28 inches; the refraction is alſo greater if the thermometer is lower than 10+; but in the oppoſite caſes the refraction is leſs than the tabular one. But the uſe of the table will better appear by an example than by any further explanation.

EXAMPLE.

Let the obſerved zenith-diſtance be 70°. 20'. 5″, the height of the barometer being 27 inc. 5 l. and that of the thermometer 4 degrees above the freezing point; the refraction is required.

By the table, the refraction anſwering to the zenith diſtance 70°. 20'. 5″ is - - -	2'. 39″,2
And the variation hereof, for 10 lines of the barometer	4, 8
For 10 degrees of the thermometer	7, 4

But as the given height of the barometer wants 7 lines of 28 inc. 0 l. ſay, as 10 l. is to 4″,8, ſo is 7 l. to a fourth number, 3″,4; further, ſince four degrees of the thermometer differ 6 degrees from 10 degrees, ſay, as 10 is to 7″,4, ſo is 6 to a fourth number, 4″,4. Hence the true refraction will be 2'. 39″,2 — 3″,4, +4″,4, or 2'. 40″,2; the firſt correction being ſubſtracted on account of the given height of the barometer being leſs, and the ſecond correction additive, becauſe the thermometer was lower than the tabluar ones.

In

† A note is added, at the bottom of the table, ſhewing its relation to the Engliſh meaſure of length, and to the ſcale of Fahrenheit's thermometer.

In a note at the bottom of the table of aſtronomical refractions, we have referred that table to the height of the barometer expreſſed in Engliſh meaſure, and to the ſcale of Fahrenheit's thermometer, to the following effect: "This table alſo anſwers to the height of "the barometer 29,6 inches, Engliſh meaſure, and to 50° of Fah- "renheit's thermometer; or to the height of the barometer 30 "Engliſh inches, and 55° of Fahrenheit's thermometer. And the "column of variation of refraction for 10 lines of the barometer, "Paris meaſure, anſwers to a difference of 9-10ths of an inch Eng- "liſh meaſure, from the given height 29,6 or 30,00 inches; and "the column of variation of refraction of 10° of Reaumur's ther- "mometer anſwers to a difference of 20° of Fahrenheit's thermo- "meter from the given degree 50 or 55°." But the author, in the 1ſt ſcholium of this problem, having obſerved, that it is not ſafe to uſe proportional parts in zenith-diſtances exceeding 80 degrees, and having therefore delivered the algebraic formula of refraction upon which the table was conſtructed, directs the refraction to be thence deduced by direct calculation in that caſe; it may therefore be uſeful to reduce the formula to the Engliſh meaſure of length, and the ſcale of Fahrenheit's thermometer. Therefore,

Let the apparent zenith-diſtance be put $= \delta$

The height of the barometer expreſſed in Engliſh inches $= \beta$

And the height of Fahrenheit's thermometer $= \theta$.

And ſubſtituting the values of $b = ,9383\,\beta$, and $t = \frac{\theta - 32}{2}$ in the formula, we ſhall have

$$\text{Refr.} = \frac{74'',408\,\beta \sin.\,\delta}{(1+0,002483\theta)^{\frac{5}{7}}}\left[\sqrt{\left(1+\frac{(17,143\cos.\,\delta)^2}{1+0,002483\,\theta}\right)} - \frac{17,143\cos.\,\delta}{(1+0,002483\theta)^{\frac{5}{7}}}\right]$$

$$= \frac{74'',408\,\beta \sin.\,\delta}{\left(1+\frac{\theta}{400}-\frac{\theta}{60000}\right)^{\frac{5}{7}}}\left[\sqrt{\left(1+\frac{(17,143\cos.\,\delta)^2}{1+\frac{\theta}{400}-\frac{\theta}{60000}}\right)} - \frac{17,143\cos.\,\delta}{\left(1+\frac{\theta}{400}-\frac{\theta}{60000}\right)^{\frac{5}{7}}}\right]$$

The computation may be very conveniently made from this formula (in a ſimilar manner to what Mayer has ſhewn with reſpect to the other formula) as follows: find an angle ω whoſe tangent is

$$= \frac{\left(1+\frac{\theta}{400}-\frac{\theta}{60000}\right)^{\frac{1}{7}}}{17,143\cos.\,\delta};$$ and the refraction is $= \frac{74'',408\,\beta \sin.\,\delta \tan.\,\frac{1}{7}\,\omega}{\left(1+\frac{\theta}{400}-\frac{\theta}{60000}\right)^{\frac{5}{7}}}$.

EXAMPLE.

On the 5th day of July 1756, the barometer ſtanding at 29,485 Engliſh inches, and Fahrenheit's thermometer at 56 degrees, the zenith-diſtance of $\lambda\ \mathfrak{m}$ was obſerved at Gottingen 88°. 7'. 34",0; the refraction is required.

θ being $= 56, \left(1+\frac{\theta}{400}-\frac{\theta}{60000}\right)^{\frac{1}{7}} = (1+,14-,00093)^{\frac{1}{7}} = \sqrt{(1,13907)}$ and

Log. $\sqrt{1,13907}$	= 0.02827
Compl. ar. log. 17,143	= 8.76592
Compl. ar. log. cof. δ	= 1.48546
Therefore tang. ω	= 10.27965
And hence ω	= 62°. 17'. 26"
and $\frac{1}{7}\,\omega$	= 31 . 8 . 43
Moreover log. tang. $\frac{1}{7}\,\omega$	9.78126
log. 74",408	1.87162
log. β or log. 29,485	1.46960
log. ſin. δ	9.99977
Compl. ar. log. $(1.13907)^{\frac{5}{7}}$	9.91519
Whence log. refr.	= 3.03744
And the refraction ſought	= 1090",0 or = 18'. 10",0

ASTRONOMY.

Ch. Mason's MAXIMA of EQUATIONS for Long. ☽.

Let ☉= Sun's mean anomaly. p=Moon's mean anomaly. *p*=Moon's anomaly corrected. ω=Moon's mean distance from the Sun's true place. ω̃=Moon's equated place from Sun's true place. δ=Moon's mean distance from the place of node corrected. ϱ=Moon's equated distance corrected by the variation from the correct place of the node.

Annual Eq. ☽ M. An.	+ 21′. 41″,5 S. Arg.	— 16″,3 S. twice Arg.	Arg. ☉ Anom.
An. Eq. ☽ ☊	+ 9′. 11″,6 S. Arg.	— 6″,7 S. twice Arg.	Arg. ☉ Anom.
1. Eq. Long.	+ 11′. 8″,6 S. Arg.	— 8″,9 S. twice Arg.	Arg. ☉ Anom.
2. Eq. Long.	— 55′,9 S. 2ω+☉		Arg. 2 ☽ á ☉+☉ Anom.
3. Eq. Long.	— 1′. 15″,3 S. 2ω—☉		Arg. 2 ☽ á ☉ — ☉ Anom.
4. Eq. Long.	+ 57″,8 S. 2ω+ p		Arg. 2 ☽ á ☉ + ☽ M. Anom.
5. Eq. Long.	—8′. 28″,4 S. 2ω—p	+ 35″,1 S. 4ω—2p	Arg. 2 ☽á ☉ — ☽ M. Anom.
6. Eq. Long.	+ 2′. 3″,5 S. 2ω—p+☉		Arg. 2 ☽á ☉ — ☽An. + ☉ Anom.
7. Eq. Long.	+ 46″,5 S. 2ω—p—☉		Arg. 2 ☽á ☉ — ☽An. — ☉ An.
8. Eq. Long.	+ 42″, S. p—☉		Arg. ☽M. An. — ☉ M. Anom.
9. Eq. Long.	+ 22″,7 S. ω—p	—57″,4 S. 2ω—2p	Arg. ☽ á ☉ — ☽M. Anom.
10. Eq. Long.	— 64″, S. 2δ—2ω		Arg. ☉ —☊ or Long. ☉ — Long. ☊
11. Eq. Long.	— 17″, S. ω+☉		Arg. ☽á ☉+ ☉ Anom.
12. Eq. Long.	— 3″,1 S. ω—☉		Arg. ☽ á ☉ —☉ Anom.
13. Eq. Long.	— 3″,7 S. 2ω+2p		Arg. 2 ☽á ☉ + 2☽ M. Anom.
14. Eq. Long.	+ 12″,4 S. 4ω—p		Arg. 4 ☽á ☉ — ☽ Anom.
15. Eq. Long.	— 6″,3 S. 2δ—2p		Arg. 2 ☽á ☊ — 2 ☽ Amom.
16. Eq. Long.	+ 8″,3 S. 2ω—2δ+p		Arg. 2 ☽ á ☉ — 2 ☽ á ☊ + ☽ Anom.
17. Eq. Long,	— 5″,3 S. 2ω—2δ—p		Arg. 2 ☽ á ☉ — 2 ☽ á ☊ — ☽ Anom.
18. Eq. Long.	+ 7″,7 S. δ		Arg. ☽ ☊
19. Eq. Long. or Eq. ☽'s Center	— 6°. 18′. 14″,2 S. *p* + 12′. 56″,9 S. 2 *p* — 36″,2 S. 3*p*		Arg. ☽ Anom. corrected by all the foregoing Eq. and the Ann. Eq. of ☽ Anom.
20. Eq. Variation ☽	— 1′. 56″,4 S. Arg. or S. ω̃ +35′. 41″,2×S. 2 Arg. or S. 2 ω̃ + 5″,2×S. 3 Arg. or S. 3 ω̃ + 8″,6×S. 4 Arg. or S. 4 ω̃		Arg. ☽ Long. corrected by all the preceding Equations — ☉ Long.
21. Eq. gives ☽ place in her orbit	+ 1′. 24″,1 S. 2ϱ—*p*		Arg. 2 ☽ á ☊ — ☽ Anom. correct.
22. Eq. Reduct. to the Ecliptic	— 6′. 47″,7 S. Arg. or S. 2ϱ		Arg. ☽ correct. — ☊ correct.
23. Equinoxes	18″, S. δ		Arg. ☽ ☊

Ch. Mason's MAXIMA of EQUATIONS of ☽'s LATITUDE.

1 Eq Lat.	+ 5°. 8′. 44″,5 S. ϱ — 4″,4 S. 3 ϱ		Arg. ☽ in Orbit — ☊ correct.
2 Eq.	+ 8′. 48″,4 S. 2 ω̃ — δ		Arg. 2 ☽ in Orbit á ☉ — Arg. 1.
3 Eq.	+ 3″,1 S. ϱ — ☉		Arg. Arg. 1 — ☉ Anom.
4 Eq.	— 17″,6 S. ϱ — p		Arg. Arg. 1 — ☽ Mean Anom.
5 Eq.	— 25″,1 S. ϱ — 2 p		Arg. Arg. 4 — ☽ M. Anom.
6 Eq.	+ 1″,9 S. ϱ — 3 p		Arg. Arg. 5 — ☽ M. Anom.
7 Eq.	— 9″, S. 2 ω̃ — ϱ + ☉		Arg. Arg. 2 + ☉ Anom.
8 Eq.	— 3″,7 S. 2 ω̃ — ϱ — ☉		Arg. Arg. 2 — ☉ Anom.
9 Eq.	— 2″,2 S. 2 ω̃ — ϱ + p		Arg. Arg. 2 + ☽ M. Anom.
10 Eq.	+ 15″,9 S. 2 ω̃ — ϱ — 2 p		Arg. Arg. 2 — ☽ M. Anom.
11 Eq.	— 5″,2 S. 2 ω̃ — ϱ — 2 p		Arg. Arg. 10 — ☽ M. Anom.

PRECEPTS *for Calculating the* Moon's Place *by Mr Mason's* Lunar Tables.

Example.

Let it be required to find the ☽'s longitude and latitude, with her horary motion and parallax for the year 1791 N. S. on the 4th of Feb. at oh. 5′. 3″ mean time at Greenwich.

Precepts.

1. Find the true longitude of the Sun, by the solar tables preceding, to the assigned time, reckoned from the mean equinox; by omitting the last of the four small equations or the equation of the equinoxes, together with his mean anomaly. By these tables you will find the true longitude of the Sun for the given instant to be

10°. 15°. 43′. 2″.=☉ long. and
7 5 12 30 =☉ mean anomaly.

2. From the tables of the epochs, take out the mean motions of the moon's mean longitude, mean anomaly, and mean long. of her ascending node, for the year, month, day, hour, minute and second of the given-time; placing each in their respective columns, and under the moon's mean-longitude, place her acceleration found in the table of Epochs.

Add up the the numbers in the columns of mean long. and mean anomaly, rejecting twelve signs whenever they occur and setting down the remainder, and you will have the mean longitude of the moon and her mean anomaly. But from the epoch of the node in the third column, subtract the sum of all the numbers placed under it, which you have collected from the tables for months, days, hours, &c. and you will have the mean longitude of

of the moon's ascending node. Thus you will have in the proposed example.

10ˢ. 26°. 8′. 12″,2 = m. Long. ☽
9 12 58 36 5 = m. Anom.
6 25 28 33 = ☽'s ☊.

3. Make two columns for receiving the positive and negative equations of the moon's longitude to be collected from the tables with their proper arguments placing each in their proper columns, according to the signs of the tables.

4. The argument of the first table for the ☽'s long. is the mean anomaly of the Sun, viz. in this example 7ˢ. 5°. 12′. 30″, with which you will find — 6′. 31″,9 to be placed in the column of negative equations.

5. If you substract the true longitude of the Sun, viz. 10ˢ. 15°. 43′. 2″. from the mean long. of the Moon, you will have the mean distance of the Moon from the Sun = 0ˢ. 10°. 25′. 10″.; to and from the double of which, viz. 0ˢ. 20°. 50′. 20″, add and substract the first argument, or ☉'s m. anom. = 7ˢ. 5°. 12′. 30″. and you will have the second and third arguments respectively; that is, for the second argument 7ˢ. 26°. 2′. 50″, by which you will find in the second table for the Moon's longitude the equation + 46″,4 to be placed in the column of positive equations in this example; and for the third argument you will have 5ˢ. 15°. 37′. 50″, with which, you will find in table the third = — 18″.7, for the column of negative equations.

6. To and from twice the Moon's mean distance from the Sun = 0ˢ. 20°. 50′. 20″, add and substract the mean anomaly of the Moon and you have the fourth and fifth argument; that is, for argument 4th in this case, 10ˢ. 3°. 49′. 65″, to which you will find — 48″. in the fourth table; and for the fifth argument you will have 3s. 7°. 51′. 3″,3, by which you will have — 3°. 19′. 52″,5 from table 5th, called the Evections.

7. To and from the fifth argument, viz. 3ˢ. 7°. 51′ 33″.5, add and substract the first argument, and you will have 10ˢ. 13°. 4′. 6″5 for the sixth argument, and 8ˢ. 2°. 39′. 3″,5, for the seventh argument by the first of which you will find — 1ˢ. 30″,2, and by the latter — 41″,3.

8. From the mean anomaly of the Moon substract the first argument or the Sun's mean anomaly, and you will have 2ˢ. 7°. 46′. 16″,5, for the eighth argument, with which, entering table 8th, you will find + 38″,9, for the equation.

9. From the mean distance of the Moon from the Sun, substract the moon's mean anomaly and you will have 2ˢ. 27°. 26′. 24″. for the ninth argument, with which in table 9th, you will have + 17″,6.

10. From the mean long. of the Moon's node substract the true long. of the Sun and you will have the tenth argument, viz. 8ˢ. 19°. 45′. 31″, with which you have in table 10th, + 39″2.

11. To the Moon's mean distance from the Sun add the Sun's anomaly, and you will have 7ˢ. 15°. 37′. 40″, for the eleventh argument, with which entering table 11th, you will find + 12″,1.

12. From the Moon's mean distance from the Sun substract the Sun's mean anomaly, and you will have 5ˢ. 5°. 12′ 40″, for the twelfth argument, with which you will find in table 12th, — 1″,3.

13. To twice the Moon's mean distance from the Sun add twice the Moon's mean anomaly, and you will have the thirteenth argument, viz. 7ˢ. 16°. 48′, with which you will find in table 13th, the equation + 2″,7.

14. From four times the Moon's mean distance from the Sun substract the Moon's mean anomaly, and you will have 3ˢ. 28°. 42′ for the fourteenth argument, with which you will find in table 14th, the equation, + 10″,9.

15. Substract the longitude of the Moon's node from the ☽'s mean longitude, and you will have her mean distance from her node, viz. 4ˢ. 0°. 39′. 39″, from the double of which, viz. 8ˢ. 10° 19′. 18″, substract the double of the Moon's mean anomaly, viz. 6ˢ. 25°. 57′. 33″, and you will have 1ˢ. 5°. 21′ 45″, for the fifteenth argument, with which you will find — 3″,6 for the equation in table 15th.

16. From the fourth argument, viz. 10ˢ. 3°. 49′. 7″, substract twice the Moon's mean distance from her node, and you will have 2ˢ. 2°. 29′ 49″, for the sixteenth argument, with which you will find + 7″,4, for the equation in table 16th.

17. From the fifth argument 3ˢ. 7°. 57′. 33″,5 substract twice the Moon's mean distance from her node, viz. 8ˢ. 1°. 19′. 18″, and you will have 7ˢ. 6°. 32′. 15″,5 for the seventeenth argument, with which you will find + 3″,2 for the equation in table 17th.

18. The mean longitude of the Moon's node is the eighteenth argument, viz. 6ˢ. 25°. 28′. 33″, with which take out the equation 3″,3 from table 18th.

19. Now add up the two columns of positive and negative equations separately and the difference of these sums with the sign of the greater is the sum of these eighteen equations of longitude. In the present case, the sum of the positive equations is + 2′. 58″,4, and the sum of the negative equations is — 1°. 29′. 52″,8, and their difference with the sign of the greater is — 1°. 26′. 54″,4 for the result of the whole eighteen preceding equations.

20. The next thing to be done is to correct the ☽'s mean anomaly, for which purpose you have a table at the beginning of the lunar tables, (the argument being the Sun's mean anomaly), which is called *the Annual Equation* of the Moon's mean anomaly. Enter this table with its proper argument, the Sun's mean anomaly, viz. 7ˢ. 5°. 12′. 30″, and you will find — 12′. 46″, which added to — 1°. 26′. 54″,4, the sum of the eighteen preceding equations found before, will give — 1°. 39′. 40″,40 for the total correction, which applied according to its sign to the Moon's mean anomaly will give 9ˢ. 11°. 19′. 6″,1 the Moon's anomaly corrected, which is the argument of table 19th, entitled, the Equation of the Moon's center, where you will find the equation of the center = + 6°. 5′. 23″,0, which add to the result of the eighteeen equations, and you will have + 4°. 38′. 28″,4 for the result of the nineteen preceding equations.

21. Apply this amount of the nineteen equations, viz. 4s. 38′. 28″,4 to the mean dist. of the Moon from the Sun, viz. 0ˢ. 10°. 25′. 10″, and you will have the argument of table 20th, entitled the Variation, viz. 0ˢ. 15°. 3′. 38″,4; or, which is the same thing, apply this result of the nineteen equations to the Moon's mean longitude, and from the corrected longitude substract the Sun's true longitude, and you will have the same argument of table 20th, with which enter table 20th, and you will find + 17′. 35″,4, which apply to the aforesaid sum + 4°. 38′. 28″,4, and the sum will be 4°. 56′, 3″,8, which applied to the mean longitude of the Moon, viz. 10ˢ. 26°. 8′. 12″,2 according to its sign, will give 11ˢ. 1°. 4′. 16″, for the correct longitude of the Moon, in her orbit.

22. Now correct the longitude of the Moon's node, by entering the table for this purpose at the beginning of the lunar tables, entitled, the annual equation of the Moon's node, with it proper argument, viz. the Sun's mean anomaly, viz. 7ˢ. 5°. 12′. 30″, and you will have 5′. 24″,7, which applied to the mean longitude of the node 6ˢ. 25°. 28′. 33″,4, according to its sign will give 6ˢ. 25°. 23′. 8″,3 for the equated long. of the Moon's asc. node.

23. From the correct longitude of the Moon, viz. 11ˢ. 1°. 4. 16″, substract the equated longitude of the Moon's node, viz. 6ˢ. 25°. 23′. 8″.3, and the remainder, viz. 4ˢ. 5°. 41′. 7″,7, will be the equated distance of the Moon from her node; from the double of which, viz. 8ˢ. 11°. 22′. 15″,4 substract the Moon's corrected anomaly, viz. 9ˢ. 11°. 19′. 6″,1, there will remain 11ˢ. 0°. 3′. 9″,3 for the twenty-first argument, with which enter

the

the 21ſt table, and you will find — 42″,0 for the equation, which apply to the correct longitude of the Moon, viz. 11ˢ. 1°. 4′. 16″, and you will have her longitude in her orbit farther corrected, viz. 11ˢ. 1°. 3′. 34″.

24. From her longitude in her orbit now found, 11ˢ. 1°. 3′. 34″. ſubſtract the equated or correct longitude of her aſcending node, found by the 22d precept, viz. 6ˢ. 25°. 23′. 8″,3, and you will have 4ˢ. 5°. 40′. 25″.7 for the argument of the 22d table, entitled Reduction, in which you will find the equation +6. 26″,3.

25. Laſtly, with the mean longitude of the Moon's node, not corrected, viz. 6ˢ. 25°. 28′. 33″ as the argument, enter the table entitled, the equation of the equinoctial points, and you will find + 7″,7, which together with the equation laſt found + 6′. 26″,3 being added to the Moon's laſt corrected longitude in her orbit, viz. 11ˢ. 1°. 3′. 34″, will give 11ˢ. 1°. 10′. 8″ for the true longitude of the Moon reduced to the ecliptic, and computed from the apparent equinox.

See the Arguments and Equations in the following Table for finding the Longitude of the Moon at the time propoſed.

						Equat. +	Equat. —
☉ Mean Anomaly	Arg. i.	7ˢ,	5°,	12′,	30″,		— 0°, 6′, 31″,9
2 ☽ á ☉ + ☉ M. Anom.	Arg. ii.	7	26	2	50	+ 00′ 46″,4	
2 ☽ á ☉ — ☉ M. Anom.	Arg. iii.	5	15	37	50		— 18 7
2 ☽ á ☉ + ☽'s M. Anom.	Arg. iv.	10	3	49	6,5		— 48
2 ☽ á ☉ — ☽'s M. Anom.	Arg. v.	3	7	51	33,5		— 1 19 52 5
2 ☽ á ☉ — ☽'s M. Anom. + ☉ An.	Arg. vi.	10	13	4	6,5		— 1 30 2
2 ☽ á ☉ — ☽'s M. Anom. — ☉'s M. An.	Arg. vii.	8	2	39	3,5		— 41 3
☽ M. Anom. — ☉'s M. Anom.	Arg. viii.	2	7	46	16,5	+ 38,9	
M. Diſt. ☽ á ☉ — ☽'s M. Anom.	Arg. ix.	2	27	26	24	+ 17,6	
Mean Long. ☊ — M. Long. ☉	Arg. x.	8	9	45	31	+ 39,2	
☽ á ☉ + ☉ Anom.	Arg. xi.	7	15	37	40	+ 12,1	
☽ á ☉ — ☉ Anom.	Arg. xii.	5	5	12	40		— 1 3
2 ☽ á ☉ + 2 ☽ M. Anom.	Arg. xiii.	7	16	48		+ 2,7	
4 ☽ á ☉ — ☽'s M. Anom.	Arg. xiv.	3	28	42		+ 10,9	
2 ☽ á ☊ — 2 ☽'s M. Anom.	Arg. xv.	1	5	21	45		— 3 6
2 ☽ á ☉ — 2 ☽ á ☊ + ☽'s M. Anom.	Arg. xvi.	2	2	29	49	+ 7,4	
2 ☽ á ☉ — 2 ☽ á ☊ — ☽'s M. Anom.	Arg. xvii.	7	6	32	15,5	+ 3,2	
Mean Longitude ☽'s ☊	Arg. xviii.	6	25	28	33		— 3 3
						+ 2 58,4	— 1 29 52 8
☽'s correct anomaly	Arg. xix.	9	11	19	6,1	+ 6 5 23	
☽'s equation long. — ☉ true longitude	Arg. xx.	0	15	3	38,4	+ 17 35,4	
Double Eq. Diſt. ☽ á ☊ — ☽'s cor. An.	Arg. xxi.	11	0	3	93		— 42
☽ Long. in orbit — correct longitude ☊	Arg. xxii.	4	5	40	25,7	+ 6 26,3	
Mean longitude ☊ ☉	Arg. xxiii.	6	25	28	33	+ 7,7	

Dif. = — 1°, 26′, 54″6

+	6	5	23	
+		17	35 4	
+	0	4	56	4
	10	26	8	12,2
☽ Long. in Orbit	11	1	4	16,2
		—	42	
	11	1	3	34,2
		+ 6		26,3
		+		7,7
☽'s true Long. =	11	1	10	8,2

PRECEPT for computing the MOON'S LATITUDE.

1. The 22d argument of longitude 4ˢ. 5°. 40′. 25″,7 found by precept 24th is the 1ſt argument of latitude, by which you have from the 1ſt table of latitude the equation + 4°. 10′. 46″,4.

2. To the 20th argument of longitude apply the ſum of the 20th and 21ſt equations of longitude, having regard to their ſigns, viz.+ 16′. 53″,4 and you have the true diſtance of the Moon in her orbit from the Sun, viz. 0ˢ. 15°. 20′. 31″,8, from the double of which 1ˢ. 0°. 41′. 3″,6, ſubſtract the 1ſt argument of latitude 4ˢ. 5°. 40′. 27″,5, and you will have 8ˢ. 25°. 0′. 37″,9 for the 2d argument of latitude, by which you get in table 2d — 8′. 46″,4 for the 2d equation of latitude.

3. From the 1ſt argument of latitude 4ˢ. 5°. 40′. 25″,7, ſubſtract the mean anomaly of the Sun 7ˢ. 5°. 12. 30′, and there will remain 9ˢ. 0°. 27′. 55″,7 for the 3d argument which gives — 3″,1.

4. From 1ſt argument 4ˢ. 5°. 40′. 25″,7, ſubſtract the mean anomaly of the Moon 9ˢ. 12°. 58′. 46″,5, and there remains 6ˢ. 22°. 41′. 39″,2 for the 4th argument, with which you get from table 4th + 6″,8.

5. From the 4th argument ſubſtract the Moon's mean anomaly, or from the firſt argument ſubſtract twice the Moon's mean anomaly, and you have 9ˢ. 9°. 42′. 52″,7 for the fifth argument of latitude, with which you find in table 5th + 24″,7.

6. From the 5th argument ſubſtract the Moon's mean anomaly; or, from the firſt argument ſubſtract three times the Moon's mean anomaly, and there remains 11ˢ. 26°. 44′. 6″,2 for the 6th argument, with which you get — 0″,1 from table 6th.

7. To argument the 2d 8ˢ. 25°. 0′. 37″,9 of latitude, add the mean anomaly of the Sun 7ˢ. 5°. 12′. 30″ and their ſum 4ˢ. 0°. 13′. 7′,9 will be the 7th argument; with which you get — 7″,8.

8. From the 2d argument of latitude 8ˢ. 25°. 0′. 37″,9 ſubſtract the mean anomaly of the Sun, and the remainder 1ˢ. 19°. 48′. 7″,9 will be the 8th argument, with which you get — 2″,8.

9. To the 2d argument of latitude 8ˢ. 25°. 0′. 37″,9, add the Moon's mean anomaly, 9ˢ, 12°. 58′. 46″,5, and the Sum 6ˢ. 7°. 59′. 24″,4 is the 9th argument, with which you have + 0″,3.

10. From the ſecond argument ſubſtract the Moon's mean anomaly, and the remainder 11ˢ. 12°. 1′. 51″.4 is the 10th argument, with which you get — 4″,9.

11. From the 10th argument ſubſtract the mean anomaly of the Moon, and the remainder 1ˢ. 29°. 3′. 4″,9 is the 11th argument, with which you find — 4″,5.

The ſum of the additive equations is 4°. 11′. 18″,2, and the ſum

ſum of the ſubſtractive equations is 9′. 9″,6 and their amount or difference + 4°. 2′. 8″,6 is the true latitude of the Moon; and it is north latitude, becauſe the ſum of the poſitive equations exceeds the ſum of the ſubſtractive or negative equations. Had the negative equations exceeded the poſitive the latitude would have been ſouth.

Problem.

To find the Equatorial Parallax *of the* MOON.

Precepts for finding the horizontal Parallax of the Mooon at the Equator.

With the firſt ten arguments for the Moon's longitude take out ſo many equations from the firſt ten tables of parallax, and the three other equations from the remaining three tables, with the 19th, 20th, and 21ſt arguments of longitude, with their proper ſigns. From the ſum of the affirmative numbers ſubſtract the ſum of the negative numbers, and the remainder is the moon's equatorial parallax, or her horizontal parallax for a place under the equator. In our example you will find the ſum of the poſitive numbers + 56′. 54″,3, and of the negative numbers — 2″,5, and their difference is 56′. 51″,8 for the equat. parallax.

To find the horizontal parallax for any latitude, and to reduce that latitude to the center of the earth, when the equat. parallax is given.

Precept.

Enter the table entitled, *for finding the horizontal parallax from the equatorial parallax, and for reducing the latitude to the earth's center*, with its argument, viz. the latitude on the ſide, and the equatorial parallax on the top, and find the reduction of parallax, which ſubſtracted from the equatorial parallax leaves the horizontal parallax required. Take alſo the reduction of the latitude from the ſame table, which ſubſtracted from the given latitude, gives the latitude reduced to the earth's center.

N. B. The parallax and reduced latitude ſhould be uſed in computing the moon's parallaxes in longitude, latitude, right aſcenſion, and declination. For hereby they may be computed by the common rules upon the ſuppoſition of the earth's being a perfect ſphere, as both are hereby referred to the center of the earth.

In our example you will find for the latitude 42°. and the equatorial parallax found above 6″,7 of a reduction to be ſubſtracted from it, to give the horizontal parallax in that latitude; and for the reduction of the latitude to the center of the earth — 14′ 51″.

The next table for finding the Moon's diameter from her equatorial parallax needs no explication, as you have her diameter anſwering to any parallax given. Or it may be found for any latitude from the horizontal parallax, by this proportion: as 54′ 56″. : 30′. 0″. : : the horizontal parallax for any latitude : to the moon's horizontal diameter required.

To find the horary motion of the Moon in longitude.

The firſt ten equations are taken from the tables of horary motion in longitude by the firſt ten arguments of longitude, and the other four with the arguments 19, 20, 21, 22. Find the ſum of the firſt thirteen of theſe equations by ſubſtracting the ſum of the negative from the ſum of the poſitive, and the moon's horary motion in her orbit will be obtained. Then ſay, as 32′. 56″, is to the Moon's horary motion in her orbit juſt found, ſo is the number taken out of the laſt table, to a fourth, which will be the ſame equation corrected, to be applied according to its ſign in the laſt table to the Moon's hourly motion in her orbit, to have her horary motion with reſpect to the ecliptic. In our example, you will find 32′. 40″,3 for the ſum of the thirteen equations, and in the 14th table + 2″,5, the reduction of which by the above proportion will be inſenſible, and therefore, the horary motion with reſpect to the ecliptic will be 32′. 42,″8.

To find the Moon's horary motion in latitude.

With argument I. and II. of latitude, take out the two equations from the two tables of the Moon's horary motion in latitude, and the ſum, if they have the ſame ſign, or their difference, if they have contrary ſigns, with the ſign of the greater will be the Moon's mean hourly motion in latitude. Then ſay, as 32′, 56″, is to the Moon's horary motion in her orbit, found by the laſt problem, ſo is the mean horary motion in latitude to her true hourly motion in latitude, which will be north, if marked with the ſign +, but ſouth if marked with the ſign —.

EQUATION of TIME.

Sun's apogee in 8°. Cancer, agreeing with the year A. C. 1716.

Argu. Sun's true Longitude.

S.	0	1	2	3	4	5	6	7	8	9	10	11	S.
	+ / —	—	+ / =	+	+	+ / —	—	—	—	= / +	+	+	
	° ′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	
0	0 7 37	1 13	3 58	1 5	5 51	2 17	7 38	15 30	13 27	1 4	11 37	14 25	0
1	7 18	1 26	3 54	1 19	5 53	2 1	7 59	15 37	13 10	0 35	11 54	14 19	1
2	6 59	1 39	3 50	1 32	5 54	1 45	8 20	15 44	12 53	0 5	12 10	14 12	2
										+			
3	6 41	1 52	3 45	1 46	5 55	1 28	8 40	15 50	12 35	0 25	12 25	14 5	3
4	6 22	2 4	3 40	1 59	5 55	1 11	9 0	15 55	12 16	0 54	12 39	13 57	4
5	6 2	2 16	3 34	2 12	5 54	0 53	9 20	15 59	11 57	1 24	12 53	13 48	5
	—												
6	5 43	2 27	3 27	2 25	5 53	0 35	9 40	16 3	11 37	1 53	13 6	13 39	6
7	5 24	2 38	3 20	2 38	5 51	0 17	10 0	16 6	11 16	2 22	13 19	13 29	7
						—							
8	5 5	2 48	3 12	2 51	5 49	0 2	10 19	16 8	10 55	2 51	13 31	13 18	8
9	4 46	2 58	3 4	3 5	5 46	0 21	10 38	16 9	10 33	3 20	13 42	13 7	9
10	4 27	3 7	2 55	3 15	5 42	0 40	10 57	16 10	10 10	3 48	13 52	12 55	10
11	4 8	3 15	2 46	3 27	5 37	1 0	11 15	16 10	9 47	4 16	14 1	12 43	11
12	3 49	3 23	2 37	3 38	5 32	1 20	11 33	16 9	9 23	4 44	14 9	12 31	12
13	3 30	3 30	2 27	3 50	5 26	1 40	11 50	16 7	8 59	5 11	14 17	12 18	13
14	3 12	3 37	2 17	4 1	5 20	2 0	12 7	16 4	8 34	5 38	14 24	12 4	14
15	2 53	3 43	2 6	4 11	5 13	2 21	12 24	16 0	8 8	6 4	14 30	11 50	15
16	2 35	3 48	1 55	4 21	5 5	2 42	12 40	15 56	7 42	6 30	14 35	11 35	16
17	2 17	3 53	1 44	4 31	4 57	3 2	12 56	15 51	7 15	6 56	14 39	11 20	17
18	1 59	3 57	1 32	4 40	4 48	3 23	13 11	15 45	6 48	7 21	14 42	11 5	18
19	1 42	4 0	1 20	4 49	4 39	3 44	13 26	15 38	6 21	7 46	14 44	10 49	19
20	1 24	4 3	1 8	4 57	4 29	4 5	13 40	15 30	5 53	8 10	14 46	10 33	20
21	1 7	4 5	0 55	5 5	4 18	4 27	13 54	15 21	5 25	8 34	14 47	10 17	21
22	0 50	4 7	0 42	5 12	4 7	4 48	14 7	15 12	4 57	8 57	14 48	10 0	22
23	0 33	4 8	0 29	5 19	3 55	5 10	14 20	15 2	4 28	9 19	14 48	9 43	23
24	0 17	4 8	0 16	5 25	3 43	5 31	14 32	14 51	3 59	9 41	14 47	9 26	24
25	0 1	4 8	0 3	5 31	3 30	5 53	14 43	14 39	3 30	10 2	14 45	9 8	25
	—		+										
26	0 15	4 7	0 11	5 36	3 16	6 14	14 54	14 26	3 1	10 22	14 42	8 50	26
27	0 30	4 6	0 24	5 41	3 2	6 35	15 4	14 12	2 32	10 42	14 39	8 32	27
28	0 45	4 4	0 38	5 45	2 47	6 56	15 13	13 58	2 3	11 1	14 35	8 14	28
29	0 59	4 1	0 52	5 48	2 32	7 17	15 22	13 43	1 34	11 19	14 30	7 56	29
30	1 13	3 58	1 5	5 51	2 17	7 38	15 30	13 27	1 4	11 37	14 25	7 37	30

☞ + Added to the apparent time, — Subtracted } to have the mean time.

EQUATION of TIME.

Sun's apogee in 9°. Cancer, agreeing with the year A. C. 1771.

Argu. Sun's true Longitude.

S.	0	1	2	3	4	5	6	7	8	9	10	11	S.
	+ / —	—	+ / =	+	+	+ / —	—	—	—	= / +	+	+	
	° ′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	
0	0 7 36	1 10	3 52	1 13	5 58	2 21	7 37	15 33	13 33	1 12	11 29	14 20	0
1	7 17	1 23	3 48	1 27	6 0	2 5	7 58	15 41	13 17	0 42	11 46	14 14	1
2	6 58	1 36	3 44	1 40	6 1	1 49	8 19	15 48	13 0	0 13	12 2	14 7	2
										+			
3	6 40	1 49	3 39	1 54	6 2	1 32	8 39	15 53	12 42	0 17	12 18	14 0	3
4	6 21	2 1	3 33	2 7	6 2	1 15	8 59	15 58	12 23	0 46	12 33	13 52	4
5	6 2	2 13	3 27	2 20	6 2	0 57	9 19	16 3	12 3	1 16	12 47	13 43	5
6	5 43	2 24	3 20	2 33	6 1	0 39	9 39	16 7	11 43	1 45	13 0	13 34	6
7	5 24	2 34	3 13	2 46	5 59	0 21	9 59	16 10	11 22	2 14	13 12	13 24	7
8	5 5	2 43	3 5	2 59	5 56	0 2	10 19	16 12	11 1	2 43	13 24	13 14	8
						—							
9	4 46	2 52	2 57	3 11	5 53	0 17	10 38	16 13	10 39	3 11	13 35	13 3	9
10	4 27	3 1	2 48	3 23	5 49	0 36	10 57	16 14	10 16	3 40	13 45	12 52	10
11	4 8	3 9	2 39	3 35	5 44	0 56	11 15	16 14	9 53	4 8	13 54	12 40	11
12	3 50	3 17	2 30	3 47	5 39	1 16	11 33	16 13	9 29	4 36	14 2	12 27	12
13	3 31	3 25	2 20	3 58	5 33	1 37	11 51	16 11	9 5	5 3	14 10	12 14	13
14	3 13	3 32	2 10	4 9	5 26	1 57	12 8	16 8	8 40	5 30	14 17	12 0	14
15	2 54	3 38	1 59	4 19	5 19	2 18	12 25	16 5	8 15	5 56	14 23	11 46	15
16	2 36	3 43	1 48	4 29	5 11	2 39	12 41	16 1	7 49	6 22	14 28	11 32	16
17	2 18	3 47	1 36	4 39	5 3	3 0	12 57	15 56	7 22	6 48	14 32	11 17	17
18	2 0	3 51	1 24	4 48	4 54	3 21	13 13	15 50	6 55	7 13	14 36	11 2	18
19	1 42	3 54	1 12	4 57	4 44	3 42	13 28	15 43	6 28	7 38	14 39	10 47	19
20	1 25	3 57	1 0	5 5	4 34	4 3	13 43	15 35	6 0	8 2	14 41	10 31	20

Difference of Time from the Meridian of Greenwich of the following Places with the Elevation of the Pole.

Names of Places.	Difference of Meridian. h ′ ″	Latitude. ° ′ ″
Madrid, *Spain*	0 15 2 +	40 25 0
Malta, *Africa*	0 57 50 —	35 54 0
Marſeilles, *France*	0 21 21 —	43 17 45
Milan, *Italy*	0 37 2 —	45 25 0
Mons, *Germany*	0 45 56 —	48 9 55
Montpelier, *France*	0 15 25 —	43 36 33
Moſcow, *Ruſſia*	2 31 1 —	55 45 20
Nantes, *France*	0 6 15 +	47 13 17
Naples, *Italy*	0 56 51 —	40 50 45
Narbonne, *France*	0 11 56 —	43 11 13
Nuremberg, *Germany*	0 44 28 —	49 27 10
Orleans, *France*	0 7 34 —	47 54 4
Paris, *France*	0 9 16 —	48 50 14
Pekin, *China*	7 45 26 —	39 55 16
Peterſburgh, *Ruſſia*	2 13 —	59 56 0
Philadelphia, *America*	5 0 35 +	39 56 54
Quebec, *America*	4 39 36 +	46 55 0
Quito, *America*	5 11 44 +	0 13 17 A.
Rimini, *Italy*	0 50 13 —	44 3 43
Rome, *Italy*	0 49 49 —	41 53 54
Siam, *India*	6 43 16 —	14 18 0
Smyrna, *Aſia*	1 49 15 —	38 28 7
Straſburg, *Germany*	0 30 56 —	48 34 35
Stockholm, *Sweden*	1 12 26 —	59 21 40
Toulon, *France*	0 23 39 —	43 7 24
Turin, *Italy*	0 30 36 —	45 5 20
Venice, *Italy*	0 49 16 —	45 27 0
Vienna, *Germany*	1 5 32 —	48 11 20
Upſal, *Sweden*	1 10 53 —	59 51 50
Uraniburg, *Sweden*	0 51 26 —	55 54 15
Wittenberg, *Germany*	0 50 46 —	51 49 0

+ Add, —Subtract } the given time of thoſe places } to have the time at Greenwich.

TABLE of the Sun's mean motion, preceſſion of the Equinoxes, and decreaſe of the obliquity of the Ecliptic, in Julian years.

Julian Years.	Mean Lon. ☉ s	°	′	″	Mean Apo. s	°	′	″	I. ☽ N.	II. ♃ N.	III. ♀ N.	IV. ☊ N.	Preceſ. Equi. s	°	′	″	Decre. ob. Ec. ″
B. 80	0	0	37	6,4	0	1	28	0	482	254	41	298	0	1	7	4,0	0 36,8
B. 100	0	0	46	23,0	0	1	50	0	853	568	551	373	0	1	23	50,0	0 46,0
B. 200	0	1	32	46,0	0	3	40	0	706	136	102	746	0	2	47	40,0	1 32,0
B. 300	0	2	19	9,0	0	5	30	0	559	704	654	118	0	4	11	30,0	2 18,0
B. 400	0	3	5	32,0	0	7	20	0	412	272	205	491	0	5	35	20,0	3 4,0
B. 500	0	3	51	55,0	0	9	10	0	265	840	756	864	0	6	59	10,0	3 50,0
B. 600	0	4	38	18,0	0	11	0	0	119	408	307	237	0	8	23	0,0	4 36,0
B. 700	0	5	24	41,0	0	12	50	0	972	976	858	609	0	9	46	50,0	5 22,0
B. 800	0	6	11	4,0	0	14	40	0	825	544	410	982	0	11	10	40,0	6 8,0
B. 900	0	6	57	27,0	0	16	30	0	678	112	961	355	0	12	34	30,0	6 54,0
B.1000	0	7	43	50,0	0	18	20	0	531	680	512	27	0	13	58	20,0	7 40,0
B.2000	0	15	27	40,0	1	6	40	0	62	359	24	455	0	27	56	40,0	15 20,0
B.3000	0	23	11	30,0	1	25	0	0	593	39	536	182	1	11	55	0,0	23 0,0
B.4000	1	0	55	20,0	2	13	20	0	124	718	48	910	1	25	53	20,0	30 40,0
B.5000	1	8	39	10,0	3	1	40	0	655	398	560	637	2	9	51	40,0	38 20,0
B.6000	1	16	23	0,0	3	20	0	0	186	78	72	365	2	23	50	0,0	46 0,0

Epochs of the Sun's mean motion.
Mean time under the meridian of Greenwich Obſervatory.

Julian Style.		Mean Long. ☉ s	°	′	″	Long. Apogee. s	°	′	″	I. ☽ N.	II. ♃ N	III. ♀ N.	IV. ☊ N.
Years before Chriſt.	600	9	3	11	2,9	1	25	32	36	87	951	918	964
	500	9	3	57	25,9	1	27	22	36	940	519	469	387
	400	9	4	43	48,9	1	29	12	36	793	87	20	709
	300	9	5	30	11,9	2	1	2	36	646	655	571	82
	200	9	6	16	34,9	2	2	52	36	499	223	122	454
	100	9	7	2	57,9	2	4	42	36	352	791	674	827
	0	9	7	49	20,9	2	6	32	36	206	359	225	200
Years after Chriſt.	100	9	8	35	43,9	2	8	22	36	59	927	776	573
	200	9	9	22	6,9	2	10	12	36	912	495	327	946
	300	9	10	8	29,9	2	12	2	36	765	63	878	318
	400	9	10	54	52,9	2	13	52	36	618	631	430	691
	500	9	11	41	15,9	2	15	42	36	471	199	981	64
	600	9	12	27	38.9	2	17	32	36	325	767	532	437
	700	9	13	14	1,9	2	19	22	36	178	335	83	809
	800	9	14	0	24,9	2	21	12	36	31	903	635	182
	900	9	14	46	47 9	2	23	2	36	884	471	186	555
	1000	9	15	33	10,9	2	24	52	36	737	39	737	927
	1100	9	16	19	33,9	2	26	42	36	590	607	288	300
	1200	9	17	5	56,9	2	28	32	36	443	175	839	673
	1300	9	17	52	19,9	3	0	22	36	296	743	381	46
	1400	9	18	38	42,9	3	2	12	36	150	311	942	418
	1460	9	19	6	32,7	3	3	18	36	262	252	473	642
	1480	9	19	15	49,3	3	3	40	36	632	65	983	716
	1500	9	19	25	5,9	3	4	2	36	3	879	493	791
	1520	9	19	34	22,5	3	4	24	36	374	193	3	866
	1540	9	19	43	39,1	3	4	46	36	744	506	514	940
	1560	9	19	52	55,7	3	5	8	36	115	820	24	15
	1580	9	20	2	12,3	3	5	30	36	485	133	534	89
	1600	9	20	11	28,9	3	5	32	36	856	444	44	163
	1620	9	20	20	45,5	3	6	14	36	227	758	554	238
	1640	9	20	30	2,1	3	6	36	36	597	71	64	313
	1660	9	20	39	18,7	3	6	58	36	968	385	574	387
	1680	9	20	48	35,3	3	7	20	36	338	698	85	462
	1700	9	20	57	51,9	3	7	42	36	708	12	595	537
	1701	9	20	43	32,6	3	7	43	42	68	927	220	591
	1702	9	20	29	13,4	3	7	44	48	428	842	845	644
	1703	9	20	14	54,1	3	7	45	54	788	757	470	698
	1704	9	20	59	43,2	3	7	47	0	182	675	97	752
	1705	9	20	45	24,0	3	7	48	6	542	590	722	806
	1706	9	20	31	4,7	3	7	49	12	902	505	347	859
	1707	9	20	16	45,5	3	7	50	18	262	420	972	913
	1708	9	21	1	34,5	3	7	51	24	656	337	599	967
	1709	9	20	47	15,3	3	7	52	30	16	252	224	20
	1710	9	20	32	56,0	3	7	53	36	376	167	849	74
	1711	9	20	18	36,8	3	7	54	42	736	82	474	128

TABLE of the Sun's mean motion, preceſſion of the Equinoxes, and decreaſe of the obliquity of the Ecliptic, in Julian years.

Julian Years.	Mean Long. ☉ s	°	′	″	Mean Apo. s	°	′	″	I. ☽ N.	II. ♃ N.	III. ♀ N	IV. ☊ N.	Prec. Equi. s	°	′	″	Decre. ob. Ec. ′	″
1	11	29	45	40,7	0	0	1	6	360	915	625	54	0	0	0	50,3	0	0,5
2	11	29	31	21,5	0	0	2	12	720	830	250	107	0	0	1	40,6	0	0,9
3	11	29	17	2,2	0	0	3	18	80	745	875	161	0	0	2	30,9	0	1,4
B. 4	0	0	1	51,3	0	0	4	24	474	663	502	215	0	0	3	21,2	0	1,8
5	11	29	47	32,1	0	0	5	30	834	578	127	268	0	0	4	11,5	0	2,3
6	11	29	33	12,8	0	0	6	36	194	493	752	322	0	0	5	1,8	0	2,8
7	11	29	18	53,6	0	0	7	42	554	408	377	376	0	0	5	52,1	0	3,2
B. 8	0	0	3	42,6	0	0	8	48	948	325	4	430	0	0	6	42,4	0	3,7
9	11	29	49	23,4	0	0	9	54	308	240	629	483	0	0	7	32,7	0	4,1
10	11	29	35	4,1	0	0	11	0	668	155	254	537	0	0	8	23,0	0	4,6
11	11	29	20	44,9	0	0	12	6	28	70	879	591	0	0	9	13,3	0	5,1
B. 12	0	0	5	34,0	0	0	13	12	422	988	506	645	0	0	10	3,6	0	5,5
13	11	29	51	14,7	0	0	14	18	782	903	131	698	0	0	10	53,9	0	6,0
14	11	29	36	55,5	0	0	15	24	142	818	756	752	0	0	11	44,2	0	6,4
15	11	29	22	36,2	0	0	16	30	502	733	381	806	0	0	12	34,5	0	6,9
B. 16	0	0	7	25,3	0	0	17	36	896	651	8	886	0	0	13	24,8	0	7,4
17	11	29	53	6,0	0	0	18	42	257	566	633	913	0	0	14	15,1	0	7,8
18	11	29	38	46,8	0	0	19	48	617	481	258	967	0	0	15	5,4	0	8,3
19	11	29	24	27,5	0	0	20	54	977	396	883	21	0	0	15	55,7	0	8,7
B. 20	0	0	9	16,6	0	0	22	0	371	314	510	75	0	0	16	46,0	0	9,2
B. 40	0	0	18	33,2	0	0	44	0	741	627	21	149	0	0	33	32,0	0	18,4
B. 60	0	0	27	49,8	0	1	6	0	112	941	531	224	0	0	50	18,0	0	27,6

Epochs of the Sun's mean motion.
Mean time under the Meridian of Greenwich Observatory.

Julian Style.	MeanLong. ☉				Long. Apo.				I. ☽	II. ☿	III. ♀	IV. ♂
	s	o	′	″	s	o	′	″	N.	N.	N.	N.
Years	1712	9	21	3	25,9	3	7	55	48	130	0	101	182
after	1713	9	20	49	6,6	3	7	56	54	490	915	726	235
Christ.	1714	9	20	34	47,4	3	7	58	0	850	830	351	289
∽	1715	9	20	20	28,1	3	7	59	6	210	745	976	343
	1716	9	21	5	17,2	3	8	0	12	604	663	603	397
	1717	9	20	50	57,9	3	8	1	18	965	578	228	450
	1718	9	20	36	38,7	3	8	2	24	325	493	853	504
	1719	9	20	22	19,4	3	8	3	30	685	408	478	558
	1720	9	21	7	8,5	3	8	4	36	79	326	105	612
	1721	9	20	52	49,2	3	8	5	42	439	241	730	665
	1722	9	20	38	30,0	3	8	6	48	799	156	355	719
	1723	9	20	24	10,7	3	8	7	54	159	71	980	773
	1724	9	21	8	59,8	3	8	9	0	553	989	607	827
	1725	9	20	54	40,6	3	8	10	6	913	904	232	880
	1726	9	20	40	21,3	3	8	11	12	273	819	857	934
	1727	9	20	26	2,1	3	8	12	18	633	734	482	988
	1728	9	21	10	51,1	3	8	13	24	27	651	109	41
	1729	9	20	56	31,9	3	8	14	30	387	566	734	95
	1730	9	20	42	12,6	3	8	15	36	747	481	359	149
	1731	9	20	27	53,4	3	8	16	42	107	396	984	203
	1732	9	21	12	42,5	3	8	17	48	501	314	611	256
	1733	9	20	58	23,2	3	8	18	54	861	229	236	310
	1734	9	20	44	4,0	3	8	20	0	221	144	861	364
	1735	9	20	29	44,7	3	8	21	6	581	59	487	418
	1736	9	21	14	33,8	3	8	22	12	975	977	114	471
	1737	9	21	0	14,5	3	8	23	18	335	892	739	525
	1738	9	20	45	55,3	3	8	24	24	695	807	364	579
	1739	9	20	31	36,0	3	8	25	30	55	722	989	633
	1740	9	21	16	25,1	3	8	26	36	449	639	616	686
	1741	9	21	2	5,8	3	8	27	42	809	554	241	740
	1742	9	20	47	46,6	3	8	28	48	169	469	866	794
	1743	9	20	33	27,3	3	8	29	54	529	384	491	848
	1744	9	21	18	16,4	3	8	31	0	923	302	118	901
	1745	9	21	3	57,2	3	8	32	6	283	217	743	955
	1746	9	20	49	37,9	3	8	33	12	643	132	368	9
	1747	9	20	35	18,7	3	8	34	18	3	47	993	62
	1748	9	21	20	7,7	3	8	35	24	397	964	620	116
	1749	9	21	5	48,5	3	8	36	30	757	879	245	170
	1750	9	20	51	29,2	3	8	37	36	117	794	870	224
	1751	9	20	37	10,0	3	8	38	42	477	709	495	277
	1752	9	21	21	59,1	3	8	39	48	871	627	122	331

Epochs of the Sun's mean motion.
Mean time under the Meridian of Greenwich Observatory.

Gregorian Style.	MeanLong. ☉				Long. Apo.				I. ☽	II. ☿	III. ♀	IV. ♂
	s	o	′	″	s	o	′	″	N.	N.	N.	N.
Years	1711	9	9	28	5,2	3	7	54	40	364	54	455	126
after	1712	9	10	12	54,3	3	7	55	46	758	972	82	180
Christ.	1713	9	9	58	35,0	3	7	56	52	118	887	707	233
∽	1714	9	9	44	15,8	3	7	57	58	478	802	332	287
	1715	9	9	29	56,5	3	7	59	4	838	717	957	341
	1716	9	10	14	45,6	3	8	0	10	232	635	584	395
	1717	9	10	0	26,3	3	8	1	16	593	550	209	448
	1718	9	9	46	7,1	3	8	2	22	953	465	834	502
	1719	9	9	31	47,8	3	8	3	28	313	380	459	556
	1720	9	10	16	36,9	3	8	4	34	707	298	86	610
	1721	9	10	2	17,6	3	8	5	40	67	213	711	663
	1722	9	9	47	58,4	3	8	6	46	427	128	336	717
	1723	9	9	33	39,1	3	8	7	52	787	43	961	771
	1724	9	10	18	28,2	3	8	8	58	181	961	588	825
	1725	9	10	4	9,0	3	8	10	4	541	876	213	878
	1726	9	9	49	49,7	3	8	11	10	901	791	838	932
	1727	9	9	35	30,5	3	8	12	16	261	706	463	986
	1728	9	10	20	19,5	3	8	13	22	655	623	90	39
	1729	9	10	6	0,3	3	8	14	28	15	538	715	93
	1730	9	9	51	41,0	3	8	15	34	375	453	340	147
	1731	9	9	37	21,8	3	8	16	40	735	368	965	201
	1732	9	10	22	10,9	3	8	17	46	129	286	592	254
	1733	9	10	7	51,6	3	8	18	52	489	201	217	308
	1734	9	9	53	32,4	3	8	19	58	849	116	842	362
	1735	9	9	39	13,1	3	8	21	4	209	31	468	416
	1736	9	10	24	2,2	3	8	22	10	603	949	95	469
	1737	9	10	9	42,9	3	8	23	16	963	864	720	523
	1738	9	9	55	23,7	3	8	24	22	323	779	345	577
	1739	9	9	41	4,4	3	8	25	28	683	694	970	631
	1740	9	10	25	53,5	3	8	26	34	77	611	597	684
	1741	9	10	11	34,2	3	8	27	40	437	526	222	738
	1742	9	9	57	15,0	3	8	28	46	797	441	847	792
	1743	9	9	42	55,7	3	8	29	52	157	356	472	846
	1744	9	10	27	44,8	3	8	30	58	551	274	99	899
	1745	9	10	13	25,6	3	8	32	4	911	189	724	953
	1746	9	9	59	6,3	3	8	33	10	271	104	349	7
	1747	9	9	44	47,1	3	8	34	16	631	19	974	60
	1748	9	10	29	36,1	3	8	35	22	25	936	601	114
	1749	9	10	15	16,9	3	8	36	28	385	851	226	168
	1750	9	10	0	57,6	3	8	37	34	745	766	851	222
	1751	9	9	46	38,4	3	8	38	40	105	681	476	275
	1752	9	10	31	27,5	3	8	39	46	499	599	103	329
	1753	9	10	17	8,2	3	8	40	52	859	514	728	383
	1754	9	10	2	49,0	3	8	41	58	219	429	353	437
	1755	9	9	48	29,7	3	8	43	4	579	344	978	490
	1756	9	10	33	18,8	3	8	44	10	973	262	605	544
	1757	9	10	18	59,5	3	8	45	16	334	177	230	598
	1758	9	10	4	40,3	3	8	46	22	694	92	855	652
	1759	9	9	50	21,0	3	8	47	28	54	7	480	705
	1760	9	10	35	10,1	3	8	48	34	448	925	107	759
	1761	9	10	20	50,8	3	8	49	40	808	840	732	813
	1762	9	10	6	31,6	3	8	50	46	168	755	357	866
	1763	9	9	52	12,3	3	8	51	52	528	670	982	920
	1764	9	10	37	1,4	3	8	52	58	922	588	60	974
	1765	9	10	22	42,2	3	8	54	4	282	502	234	27
	1766	9	10	8	22,9	3	8	55	10	642	418	359	81
	1767	9	9	54	3,7	3	8	56	16	2	333	484	135
	1768	9	10	38	52,7	3	8	57	22	396	250	111	189
	1769	9	10	24	33,5	3	8	58	28	756	165	736	242
	1770	9	10	10	14,2	3	8	59	34	116	80	361	296
	1771	9	9	55	55,0	3	9	0	40	476	995	986	350
	1772	9	10	40	44,1	3	9	1	46	870	913	613	404

Epochs of the Sun's mean motion for the meridian of Philadelphia.

New Style.		☉ mean Long.				Long. Apog.				I. ☽	II. ☿	III. ♀	IV. ♂
		s	o	′	″	s	o	′	″	N.	N.	N.	N.
Years of	1765	9	10	35	2,8	3	8	54	4	289	504	234	27
Christ.	1766	9	10	20	43,5	3	8	55	10	649	419	859	81
	1767	9	10	6	24,3	3	8	56	16	9	334	484	135
	1768	9	10	51	13,3	3	8	57	22	403	251	111	189
	1769	9	10	36	54,1	3	8	58	28	763	166	736	242
	1770	9	10	22	34,8	3	8	59	34	123	81	361	296
	1771	9	10	8	15,6	3	9	0	40	483	996	986	350
	1772	9	10	53	4,7	3	9	1	46	877	914	613	404
	1773	9	10	38	45,4	3	9	2	52	237	829	238	458
	1774	9	10	24	26,2	3	9	3	58	597	744	863	511
	1775	9	10	10	6,9	3	9	5	4	957	659	488	565
	1776	9	10	54	56,0	3	9	6	10	351	577	115	619
	1777	9	10	40	36,7	3	9	7	16	712	492	740	672
	1778	9	10	26	17,5	3	9	8	22	72	407	365	726
	1779	9	10	11	58,2	3	9	9	28	432	322	990	780
	1780	9	10	56	47,3	3	9	10	34	826	240	617	834
	1781	9	10	42	28,0	3	9	11	40	186	155	242	887
	1782	9	10	28	8,8	3	9	12	46	546	70	867	941
	1783	9	10	13	49,5	3	9	13	52	906	985	492	994
	1784	9	10	58	38,6	3	9	14	58	300	903	119	48
	1785	9	10	44	19,4	3	9	16	4	660	818	744	102
	1786	9	10	30	0,1	3	9	17	10	20	733	369	156
	1787	9	10	15	40,9	3	9	18	16	380	648	994	209
	1788	9	11	0	29,9	3	9	19	22	774	565	621	263
	1789	9	10	46	10,7	3	9	20	28	134	480	246	317
	1790	9	10	31	51,4	3	9	21	34	494	395	871	371
	1791	9	10	17	32,2	3	9	22	40	854	310	496	424
	1792	9	11	2	21,3	3	9	23	46	248	228	123	478
	1793	9	10	48	2,0	3	9	24	52	608	143	748	532
	1794	9	10	33	42,8	3	9	25	58	968	58	373	585
	1795	9	10	19	23,5	3	9	27	4	328	973	998	639
	1796	9	11	4	12,6	3	9	28	10	722	891	625	693
	1797	9	10	49	53,3	3	9	29	16	82	806	250	747
	1798	9	10	35	34,1	3	9	30	22	442	721	875	800
	1799	9	10	21	14,8	3	9	31	28	802	636	500	854
	1800	9	10	6	55,6	3	9	32	34	162	551	125	907
	1801	9	9	52	36,3	3	9	33	40	522	466	750	961
	1802	9	9	38	17,0	3	9	34	46	882	381	375	15
	1803	9	9	23	57,7	3	9	35	52	242	296	0	69
	1804	9	10	8	46,9	3	9	36	58	636	213	627	123
	1805	9	9	54	27,7	3	9	38	4	996	128	252	176
	1806	9	9	40	8,4	3	9	39	10	356	43	877	230
	1807	9	9	25	49,1	3	9	40	16	716	958	502	284
	1808	9	10	10	38,2	3	9	41	22	110	876	129	338
	1809	9	9	56	19,0	3	9	42	28	470	791	755	391
	1810	9	9	41	59,7	3	9	43	34	830	706	380	445
	1811	9	9	27	40,5	3	9	44	40	190	621	5	499
	1812	9	10	12	29,6	3	9	45	46	584	539	632	553
	1813	9	9	58	10,3	3	9	46	52	944	454	257	606
	1814	9	9	43	51,1	3	9	47	58	304	369	882	660
	1815	9	9	29	31,8	3	9	49	4	664	284	507	714
	1816	9	10	14	20,9	3	9	50	10	58	201	134	768
	1817	9	10	0	1,6	3	9	51	16	418	116	759	821
	1818	9	9	45	42,4	3	9	52	22	778	31	384	875
	1819	9	9	31	23,1	3	9	53	28	138	946	09	929
	1820	9	10	16	12,2	3	9	54	34	532	864	636	983
	1821	9	10	1	52,9	3	9	55	40	892	779	261	36
	1822	9	9	47	33,7	3	9	56	46	252	684	886	90
	1823	9	9	33	14,4	3	9	57	52	612	609	511	144
	1824	9	10	18	3,5	3	9	58	58	6	527	138	198
	1825	9	10	3	44,3	3	10	0	4	366	442	763	251
	1826	9	9	49	25,0	3	10	1	10	726	357	388	305

Epochs of the Sun's mean motion for the meridian of Philadelphia.

New Style.		☉ mean Long.				Long. Apo.				I. ☽	II. ☿	III. ♀	IV. ♂
		s	o	′	″	s	o	′	″	N.	N.	N.	N.
Years of	1827	9	9	35	5,8	3	10	2	16	86	272	13	359
Christ.	1828	9	10	19	54,9	3	10	3	22	480	190	640	413
	1829	9	10	5	35,6	3	10	4	28	840	105	265	466
	1830	9	9	51	16,3	3	10	5	34	200	20	890	520
	1831	9	9	36	57,1	3	10	6	40	560	935	515	574
	1832	9	10	21	46,2	3	10	7	46	954	852	142	628
	1833	9	10	7	26,9	3	10	8	52	314	767	767	681
	1834	9	9	53	7,7	3	10	9	58	674	682	392	735

Table of the Sun's mean motion, in Months and Days.

JANUARY.

Days.	Longitude ☉				Apo.	I. ☽	II. ☿	III. ♀	IV. ♂	Pre. Eq.
	s	o	′	″	″	N.	N.	N.	N.	″
1	0	0	59	8,3	0	34	3	2	0	0,1
2	0	1	58	16,7	0	68	5	3	0	0,3
3	0	2	57	25,0	1	102	8	5	0	0,4
4	0	3	56	33,3	1	135	10	7	1	0,6
5	0	4	55	41,7	1	169	13	9	1	0,7
6	0	5	54	50,0	1	203	15	10	1	0,8
7	0	6	53	58,3	1	237	18	12	1	1,0
8	0	7	53	6,6	1	271	20	14	1	1,1
9	0	8	52	15,0	2	305	23	15	1	1,2
10	0	9	51	23,3	2	339	25	17	1	1,4
11	0	10	50	31,6	2	372	28	19	2	1,5
12	0	11	49	40,0	2	406	30	21	2	1,7
13	0	12	48	48,3	2	440	33	22	2	1,8
14	0	13	47	56,6	3	474	35	24	2	1,9
15	0	14	47	5,0	3	508	38	26	2	2,1
16	0	15	46	13,3	3	542	40	27	2	2,2
17	0	16	45	21,6	3	576	43	29	3	2,3
18	0	17	44	30,0	3	610	45	31	3	2,5
19	0	18	43	38,3	3	643	48	33	3	2,6
20	0	19	42	46,6	4	677	50	34	3	2,8
21	0	20	41	54,9	4	710	53	36	3	2,9
22	0	21	41	3,3	4	745	55	38	3	3,0
23	0	22	40	11,6	4	779	58	39	3	3,2
24	0	23	39	19,9	4	813	60	41	4	3,3
25	0	24	38	28,3	5	847	63	43	4	3,4
26	0	25	37	36,6	5	880	65	45	4	3,6
27	0	26	36	44,9	5	914	68	46	4	3,7
28	0	27	35	53,3	5	948	70	48	4	3,9
29	0	28	35	1,6	5	982	73	50	4	4,0
30	0	29	34	9,9	5	16	75	51	4	4,1
31	1	0	33	18,3	6	50	78	53	5	4,3

FEBRUARY.

Days.	Longitude ☉				Apo.	I. ☽	II. ☿	III. ♀	IV. ♂	Pre. Eq.
	s	o	′	″	″	N.	N.	N.	N.	″
1	1	1	32	26,6	6	84	80	55	5	4,4
2	1	2	31	34,9	6	117	83	57	5	4,5
3	1	3	30	43,2	6	151	85	58	5	4,7
4	1	4	29	51,6	6	185	88	60	5	4,8
5	1	5	28	59,9	7	219	90	62	5	5,0
6	1	6	28	8,2	7	253	93	63	5	5,1
7	1	7	27	16,6	7	287	95	65	6	5,2

Table of the Sun's mean motion, In Months and Days.

FEBRUARY.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ☿ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
8	1	8	26	24,9	7	321	98	67	6	5,4
9	1	9	25	33,2	7	355	100	69	6	5,5
10	1	10	24	41,6	7	388	103	70	6	5,6
11	1	11	23	49,9	8	422	105	72	6	5,8
12	1	12	22	58,2	8	456	108	74	6	5,9
13	1	13	22	6,6	8	490	110	75	6	6,1
14	1	14	21	14,9	8	524	113	77	7	6,2
15	1	15	20	23,2	8	558	115	79	7	6,3
16	1	16	19	31,5	8	592	118	80	7	6,5
17	1	17	18	39,9	9	625	120	82	7	6,6
18	1	18	17	48,2	9	659	123	84	7	6,7
19	1	19	16	56,5	9	693	125	86	7	6,9
20	1	20	16	4,9	9	727	128	87	8	7,0
21	1	21	15	13,2	9	761	130	89	8	7,2
22	1	22	14	21,5	10	795	133	91	8	7,3
23	1	23	13	29,9	10	829	135	92	8	7,4
24	1	24	12	38,2	10	862	138	94	8	7,6
25	1	25	11	46,5	10	896	140	96	8	7,7
26	1	26	10	54,9	10	930	143	98	8	7,8
27	1	27	10	3,2	11	964	145	99	9	8,0
28	1	28	9	11,5	11	998	148	101	9	8,1

MARCH.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ☿ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
1	1	29	8	19,8	11	32	150	103	9	8,3
2	2	0	7	28,2	11	66	153	104	9	8,4
3	2	1	6	36,5	11	100	155	106	9	8,5
4	2	2	5	44,8	11	133	158	108	9	8,7
5	2	3	4	53,2	12	167	160	110	9	8,8
6	2	4	4	1,5	12	201	163	111	10	9,0
7	2	5	3	9,8	12	235	165	113	10	9,1
8	2	6	2	18,2	12	269	168	115	10	9,2
9	2	7	1	26,5	12	303	170	116	10	9,4
10	2	8	0	34,8	13	337	173	118	10	9,5
11	2	8	59	43,2	13	370	175	120	10	9,6
12	2	9	58	51,5	13	404	178	122	10	9,8
13	2	10	57	59,8	13	438	181	123	11	9,9
14	2	11	57	8,1	13	472	183	125	11	10,1
15	2	12	56	16,5	13	506	186	127	11	10,2
16	2	13	55	24,8	14	540	188	128	11	10,3
17	2	14	54	33,1	14	574	191	130	11	10,5
18	2	15	53	41,5	14	607	193	132	11	10,6
19	2	16	52	49,8	14	641	196	134	11	10,7
20	2	17	51	58,1	14	675	198	135	12	10,9
21	2	18	51	6,5	15	709	201	137	12	11,0
22	2	19	50	14,8	15	743	203	139	12	11,2
23	2	20	49	23,1	15	777	206	140	12	11,3
24	2	21	48	31,5	15	811	208	142	12	11,4
25	2	22	47	39,8	15	844	211	144	12	11,6
26	2	23	46	48,1	15	878	213	146	13	11,7
27	2	24	45	56,4	16	912	216	147	13	11,8
28	2	25	45	4,8	16	946	218	149	13	12,0
29	2	26	44	13,1	16	980	221	151	13	12,1
30	2	27	43	21,4	16	14	223	152	13	12,3
31	2	28	42	29,8	16	48	226	154	13	12,4

Table of the Sun's mean motion, In Months and Days.

APRIL.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ☿ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
1	2	29	41	38,1	16	82	228	156	13	12,5
2	3	0	40	46,4	16	115	231	158	14	12,7
3	3	1	39	54,8	17	149	233	159	14	12,8
4	3	2	39	3,1	17	183	236	161	14	12,9
5	3	3	38	11,4	17	217	238	163	14	13,1
6	3	4	37	19,8	17	251	241	164	14	13,2
7	3	5	36	28,1	17	285	243	166	14	13,4
8	3	6	35	36,4	18	319	246	168	14	13,5
9	3	7	34	44,8	18	352	248	170	15	13,6
10	3	8	33	53,1	18	386	251	171	15	13,8
11	3	9	33	1,4	18	420	253	173	15	13,9
12	3	10	32	9,7	18	454	256	175	15	14,0
13	3	11	31	18,1	19	488	258	176	15	14,2
14	3	12	30	26,4	19	522	261	178	15	14,3
15	3	13	29	34,7	19	556	263	180	15	14,5
16	3	14	28	43,1	19	589	266	182	16	14,6
17	3	15	27	51,4	19	623	268	183	16	14,7
18	3	16	26	59,7	20	657	271	185	16	14,9
19	3	17	26	8,1	20	691	273	187	16	15,0
20	3	18	25	16,4	20	725	275	188	16	15,1
21	3	19	24	24,7	20	759	278	190	16	15,3
22	3	20	23	33,1	20	793	281	192	16	15,4
23	3	21	22	41,4	20	827	283	194	17	15,6
24	3	22	21	49,7	21	860	286	195	17	15,7
25	3	23	20	58,0	21	894	288	197	17	15,8
26	3	24	20	6,4	21	928	291	199	17	16,0
27	3	25	19	14,7	21	962	293	200	17	16,1
28	3	26	18	23,0	21	996	296	202	17	16,2
29	3	27	17	31,4	22	30	298	204	18	16,4
30	3	28	16	39,7	22	64	301	206	18	16,5

MAY.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ☿ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
1	3	29	15	48,0	22	97	303	207	18	16,7
2	4	0	14	56,4	22	131	306	209	18	16,8
3	4	1	14	4,7	22	165	308	211	18	16,9
4	4	2	13	13,0	22	199	311	212	18	17,1
5	4	3	12	21,4	23	233	313	214	18	17,2
6	4	4	11	29,7	23	267	316	216	19	17,4
7	4	5	10	38,0	23	301	318	217	19	17,5
8	4	6	9	46,3	23	334	321	218	19	17,6
9	4	7	8	54,7	23	368	323	221	19	17,8
10	4	8	8	3,0	24	402	326	223	19	17,9
11	4	9	7	11,3	24	436	328	224	19	18,0
12	4	10	6	19,7	24	470	331	226	19	18,2
13	4	11	5	28,0	24	504	333	228	20	18,3
14	4	12	4	36,3	24	538	336	229	20	18,5
15	4	13	3	44,7	24	572	338	231	20	18,6
16	4	14	2	53,0	25	605	341	233	20	18,7
17	4	15	2	1,3	25	639	343	235	20	18,9
18	4	16	1	9,7	25	673	346	236	20	19,0
19	4	17	0	18,0	25	707	348	238	20	19,1
20	4	17	59	26,3	25	741	351	240	21	19,3
21	4	18	58	34,6	25	775	353	241	21	19,4
22	4	19	57	43,0	26	809	356	243	21	19,6
23	4	20	56	51,3	26	842	359	245	21	19,7
24	4	21	55	59,6	26	876	361	247	21	19,8

Table of the Sun's mean motion, In Months and Days.

MAY.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ♃ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
25	4	22	55	8,0	26	910	364	248	21	20,0
26	4	23	54	16,3	26	944	366	250	21	20,1
27	4	24	53	24,6	27	978	369	252	22	20,2
28	4	25	52	33,0	27	12	371	253	22	20,4
29	4	26	51	41,3	27	46	374	255	22	20,5
30	4	27	50	49,6	27	79	376	257	22	20,7
31	4	28	49	58,0	27	113	379	259	22	20,8

JUNE.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ♃ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
1	4	29	49	6,3	27	147	381	260	22	20,9
2	5	0	48	14,6	28	181	384	262	23	21,1
3	5	1	47	22,9	28	215	386	264	23	21,2
4	5	2	46	31,3	28	249	389	265	23	21,3
5	5	3	45	39,6	28	283	391	267	23	21,5
6	5	4	44	47,9	28	317	394	269	23	21,6
7	5	5	43	56,3	29	350	396	271	23	21,8
8	5	6	43	4,6	29	384	399	272	23	21,9
9	5	7	42	12,9	29	418	401	274	24	22,0
10	5	8	41	21,3	29	452	404	276	24	22,2
11	5	9	40	29,6	29	486	406	277	24	22,3
12	5	10	39	37,9	30	520	409	279	24	22,4
13	5	11	38	46,3	30	554	411	281	24	22,6
14	5	12	37	54,6	30	587	414	283	24	22,7
15	5	13	37	2,9	30	621	416	284	24	22,9
16	5	14	36	11,2	30	655	419	286	25	23,0
17	5	15	35	19,6	30	689	421	288	25	23,1
18	5	16	34	27,9	31	723	424	289	25	23,3
19	5	17	33	36,2	31	757	426	291	25	23,4
20	5	18	32	44,6	31	791	429	293	25	23,5
21	5	19	31	52,9	31	824	431	295	25	23,7
22	5	20	31	1,2	31	858	434	296	25	23,8
23	5	21	30	9,6	31	892	436	298	26	24,0
24	5	22	29	17,9	32	926	439	300	26	24,1
25	5	23	28	26,2	32	960	441	301	26	24,2
26	5	24	27	34,6	32	994	444	303	26	24,4
27	5	25	26	42,9	32	28	446	305	26	24,5
28	5	26	25	51,2	32	62	448	307	26	24,6
29	5	27	24	59,5	33	95	451	308	26	24,8
30	5	28	24	7,9	33	129	454	310	27	24,9

JULY.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ♃ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″.
1	5	29	23	16,2	33	163	456	312	27	25,1
2	6	0	22	24,5	33	197	459	313	27	25,2
3	6	1	21	32,9	33	231	461	315	27	25,3
4	6	2	20	41,2	33	265	464	317	27	25,5
5	6	3	19	49,5	34	299	466	319	27	25,6
6	6	4	18	57,9	34	332	469	320	28	25,8
7	6	5	18	6,2	34	366	471	322	28	25,9
8	6	6	17	14,5	34	400	474	324	28	26,0
9	6	7	16	22,9	34	434	476	325	28	26,2
10	6	8	15	31,2	35	468	479	327	28	26,3
11	6	9	14	39,5	35	502	481	329	28	26,4

Table of the Sun's mean motion, In Months and Days.

JULY.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ♃ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
12	6	10	13	47,8	35	536	484	331	28	26,6
13	6	11	12	56,2	35	569	486	332	29	26,7
14	6	12	12	4,5	35	603	489	334	29	26,9
15	6	13	11	12,8	35	637	491	336	29	27,0
16	6	14	10	21,2	36	671	494	337	29	27,1
17	6	15	9	29,5	36	705	496	339	29	27,3
18	6	16	8	37,8	36	739	499	341	29	27,4
19	6	17	7	46,2	36	773	501	343	29	27,5
20	6	18	6	54,5	36	806	504	344	30	27,7
21	6	19	6	2,8	37	840	506	346	30	27,8
22	6	20	5	11,2	37	874	509	348	30	28,0
23	6	21	4	19,5	37	908	511	349	30	28,1
24	6	22	3	27,8	37	942	514	351	30	28,2
25	6	23	2	36,1	37	976	516	353	30	28,4
26	6	24	1	44,5	37	10	519	354	30	28,5
27	6	25	0	52,8	38	44	521	356	31	28,6
28	6	26	0	1,1	38	77	524	358	31	28,8
29	6	26	59	9,5	38	111	526	360	31	28,9
30	6	27	58	17,8	38	145	529	361	31	29,1
31	6	28	57	26,1	38	179	531	363	31	29,2

Table of the Sun's mean motion, In Months and Days.

AUGUST.

Days.	Longitude ☉ s	o	′	″	Apo. ″	I. ☽ N.	II. ♃ N.	III. ♀ N.	IV. ♂ N.	Pre. Eq. ″
1	6	29	56	34,5	39	213	534	365	31	29,3
2	7	0	55	42,8	39	247	536	366	31	29,5
3	7	1	54	51,1	39	281	539	368	32	29,6
4	7	2	53	59,5	39	314	542	370	32	29,7
5	7	3	53	7,8	39	348	544	372	32	29,9
6	7	4	52	16,1	39	382	547	373	32	30,0
7	7	5	51	24,4	40	416	549	375	32	30,2
8	7	6	50	32,8	40	450	552	377	32	30,3
9	7	7	49	41,1	40	484	554	378	33	30,4
10	7	8	48	49,4	40	518	557	380	33	30,6
11	7	9	47	57,8	40	551	559	382	33	30,7
12	7	10	47	6,1	41	585	562	384	33	30,8
13	7	11	46	14,4	41	619	564	385	33	31,0
14	7	12	45	22,8	41	653	567	387	33	31,1
15	7	13	44	31,1	41	687	569	389	33	31,3
16	7	14	43	39,4	41	721	572	390	34	31,4
17	7	15	42	47,8	41	755	574	392	34	31,5
18	7	16	41	56,1	42	789	577	394	34	31,7
19	7	17	41	4,4	42	822	579	396	34	31,8
20	7	18	40	12,7	42	856	582	397	34	31,9
21	7	19	39	21,1	42	890	584	399	34	32,1
22	7	20	38	29,4	42	924	587	401	34	32,2
23	7	21	37	37,7	43	958	589	402	35	32,4
24	7	22	36	46,1	43	992	592	404	35	32,5
25	7	23	35	54,4	43	26	594	406	35	32,6
26	7	24	35	2,7	43	59	597	408	35	32,8
27	7	25	34	11,1	43	93	599	409	35	32,9
28	7	26	33	19,4	43	127	602	411	35	33,1
29	7	27	32	27,7	44	161	604	413	35	33,2
30	7	28	31	36,1	44	195	607	414	36	33,3
31	7	29	30	44,4	44	229	609	416	36	33,5

Table of the Sun's mean motion, In Months and Days.

SEPTEMBER.

Days.	Longitude ☉	Apo.	I. ☽	II. ♃	III. ♀	IV. ♂	Pre. Eq.
	s o ′ ″	″	N.	N.	N.	N.	″
1	8 0 29 52,7	44	263	612	418	36	33,6
2	8 1 29 1,0	44	296	614	420	36	33,7
3	8 2 28 9,4	44	330	617	421	36	33,9
4	8 3 27 17,7	45	364	619	423	36	34,0
5	8 4 26 26,0	45	398	622	425	36	34,2
6	8 5 25 34,4	45	432	624	426	37	34,3
7	8 6 24 42,7	45	466	627	428	37	34,4
8	8 7 23 51,0	45	500	629	430	37	34,6
9	8 8 22 59,4	45	534	632	432	37	34,7
10	8 9 22 7,7	46	567	634	433	37	34,8
11	8 10 21 16,0	46	601	637	435	37	35,0
12	8 11 20 24,4	46	635	639	437	38	35,1
13	8 12 19 32,7	46	669	642	438	38	35,3
14	8 13 18 41,0	46	703	644	440	38	35,4
15	8 14 17 49,4	47	737	647	442	38	35,5
16	8 15 16 57,7	47	771	649	444	38	35,7
17	8 16 16 6,0	47	804	652	445	38	35,8
18	8 17 15 14,3	47	838	654	447	38	35,9
19	8 18 14 22 7	47	872	657	449	39	36,1
20	8 19 13 31,0	48	906	659	450	39	36,2
21	8 20 12 39,3	48	940	662	452	39	36,4
22	8 21 11 47,7	48	974	664	454	39	36,5
23	8 22 10 56,0	48	8	667	456	39	36,6
24	8 23 10 4,3	48	41	669	457	39	36,8
25	8 24 9 12,7	48	75	672	459	39	36,9
26	8 25 8 21,0	49	109	674	461	40	37,0
27	8 26 7 29,3	49	143	677	462	40	37,2
28	8 27 6 37,7	49	177	679	464	40	37,3
29	8 28 5 46,0	49	211	682	466	40	37,5
30	8 29 4 54,3	49	245	684	468	40	37,6

OCTOBER.

Days.	Longitude ☉	Apo.	I. ☽	II. ♃	III. ♀	IV. ♂	Pre. Eq.
	s o ′ ″	″	N.	N	N.	N.	″
1	9 0 4 2,6	50	279	687	469	40	37,8
2	9 1 3 11,0	50	312	689	471	40	37,9
3	9 2 2 19,3	50	346	692	473	41	38,0
4	9 3 1 27,6	50	380	694	474	41	38,1
5	9 4 0 36,0	50	414	697	476	41	38,3
6	9 4 59 44,3	50	448	699	478	41	38,4
7	9 5 58 52,6	51	482	702	480	41	38,6
8	9 6 58 1,0	51	516	704	481	41	38,7
9	9 7 57 9,3	51	549	707	483	41	38,8
10	9 8 56 17,6	51	583	709	485	42	39,0
11	9 9 55 26,0	51	617	712	486	42	39,1
12	9 10 54 34,3	52	651	714	488	42	39,2
13	9 11 53 42,6	52	685	717	490	42	39,4
14	9 12 52 50,9	52	719	720	491	42	39,5
15	9 13 51 59,3	52	753	722	493	42	39,7
16	9 14 51 7,6	52	786	725	495	43	39,8
17	9 15 50 15,9	52	820	727	497	43	39,9
18	9 16 49 24,3	53	854	730	498	43	40,1
19	9 17 48 32,6	53	888	732	500	43	40,2
20	9 18 47 40,9	53	922	735	502	43	40,3
21	9 19 46 49,3	53	956	737	503	43	40,5
22	9 20 45 57,6	53	990	740	505	43	40,6
23	9 21 45 5,9	53	24	742	507	44	40,8
24	9 22 44 14,3	54	57	745	509	44	40,9
25	9 23 43 22,6	54	91	747	510	44	41,0
26	9 24 41 30,9	54	124	750	512	44	41,2
27	9 25 41 39,2	54	159	752	514	44	41,3
28	9 26 40 47,6	54	193	755	515	44	41,5
29	9 27 39 55,9	55	227	757	517	44	41,6
30	9 28 39 4,2	55	261	760	519	45	41,7
31	9 29 38 12,6	55	294	762	521	45	41,9

Table of the Sun's mean motion, In Months and Days.

NOVEMBER.

Days.	Longitude ☉	Apo.	I. ☽	II. ♃	III. ♀	IV. ♂	Pre. Eq.
	s o ′ ″	′ ″	N.	N.	N.	N.	″
1	10 0 37 20,9	55	328	765	522	45	42,0
2	10 1 36 29,2	55	362	767	524	45	42,1
3	10 2 35 37,6	55	396	770	526	45	42,3
4	10 3 34 45,0	56	430	772	527	45	42,4
5	10 4 33 54,2	56	464	775	529	45	42,6
6	10 5 33 2,6	56	498	777	531	46	42,7
7	10 6 32 10,9	56	531	780	533	46	42,8
8	10 7 31 19,2	56	565	782	534	46	43,0
9	10 8 30 27,5	57	599	785	536	46	43,1
10	10 9 29 35,9	57	633	787	538	46	43,2
11	10 10 28 44,2	57	667	790	539	46	43,4
12	10 11 27 52,5	57	701	792	541	46	43,5
13	10 12 27 0,9	57	735	795	543	47	43,7
14	10 13 26 9,2	58	768	797	545	47	43,8
15	10 14 25 17,5	58	802	800	546	47	43,9
16	10 15 24 25,9	58	836	802	548	47	44,1
17	10 16 23 34,2	58	870	805	550	47	44,2
18	10 17 22 42,5	58	904	807	551	47	44,3
19	10 18 21 50,9	58	938	810	553	48	44,5
20	10 19 20 59,2	59	972	812	555	48	44,6
21	10 20 20 7,5	59	6	815	557	48	44,8
22	10 21 19 15,8	59	39	817	558	48	44,9
23	10 22 18 24,2	59	73	820	560	48	45,0
24	10 23 17 32,5	59	107	822	562	48	45,2
25	10 24 16 40,8	1 0	141	825	563	48	45,3
26	10 25 15 49,2	1 0	175	827	565	49	45,4
27	10 26 14 57,5	1 0	209	830	567	49	45,6
28	10 27 14 5,8	1 0	243	832	569	49	45,7
29	10 28 13 14,2	1 0	276	835	570	49	45,9
30	10 29 12 22,5	1 0	310	837	572	49	46,0

DECEMBER.

Days.	Longitude ☉	Apo.	I. ☽	II. ♃	III. ♀	IV. ♂	Pre. Eq.
	s o ′ ″	′ ″	N.	N.	N.	N.	″
1	11 0 11 30,8	1 1	344	840	574	49	46,1
2	11 1 10 39,2	1 1	378	842	575	49	46,3
3	11 2 9 47,5	1 1	412	845	577	50	46,4
4	11 3 8 55,8	1 1	446	847	579	50	46,5
5	11 4 8 4,1	1 1	480	850	581	50	46,7
6	11 5 7 12,5	1 1	513	852	582	50	46,8
7	11 6 6 20,8	1 2	547	855	584	50	47,0
8	11 7 5 29,1	1 2	581	857	586	50	47,1
9	11 8 4 37,5	1 2	615	860	587	50	47,2
10	11 9 3 45,8	1 2	649	862	589	51	47,4
11	11 10 2 54,1	1 2	683	865	591	51	47,5
12	11 11 2 2,5	1 3	717	867	593	51	47,6
13	11 12 1 10,8	1 3	751	870	594	51	47,8
14	11 13 0 19,1	1 3	784	872	596	51	47,9
15	11 13 59 27,5	1 3	818	875	598	51	48,1
16	11 14 58 35,8	1 3	852	877	599	51	48,2
17	11 15 57 44,1	1 3	886	880	601	52	48,3
18	11 16 56 52,4	1 4	920	882	603	52	48,5
19	11 17 56 0,8	1 4	954	885	605	52	48,6
20	11 18 55 9,1	1 4	988	887	606	52	48,7
21	11 19 54 17,4	1 4	21	890	608	52	48,9
22	11 20 53 25,8	1 4	55	892	610	52	49,0
23	11 21 52 34,1	1 5	89	895	611	53	49,2
24	11 22 11 42,4	1 5	123	898	613	53	49,3
25	11 23 50 50,8	1 5	157	900	615	53	49,4
26	11 24 49 59,1	1 5	191	903	617	53	49,6
27	11 25 49 7,4	1 5	225	905	618	53	49,7
28	11 26 48 15,8	1 5	258	908	620	53	49,9
29	11 27 47 24,1	1 6	292	910	622	53	50,0
30	11 28 46 32,4	1 6	326	913	623	54	50,1
31	11 29 45 40,7	1 6	360	915	625	54	50,3

Table of the Sun's mean motion, in Hours and Minutes.

In Hours.					In Minutes.				In Seconds.			
	Lon. ☉	I. ☽	II. ♃	III. ♀	Lo. ☉		Lo. ☉		L. ☉		L. ☉	
h	° ′ ″	N.	N.	N.	′	′ ″	′	′ ″	″	″	″	″
1	2 27,8	1	0	0	1	0 2,5	31	1 16,4	1	0,0	31	1,3
2	4 55,7	3	0	0	2	0 4,9	32	1 18,8	2	0,1	32	1,3
3	7 23,5	4	0	0	3	0 7,4	33	1 21,3	3	0,1	33	1,4
4	9 51,4	6	0	0	4	0 9,9	34	1 23,8	4	0,2	34	1,4
5	12 19,2	7	1	0	5	0 12,3	35	1 26,2	5	0,2	35	1,4
6	14 47,1	8	1	0	6	0 14,8	36	1 28,7	6	0,2	36	1,5
7	17 14,9	10	1	0	7	0 17,2	37	1 31,2	7	0,3	37	1,5
8	19 42.8	11	1	1	8	0 19,7	38	1 33,6	8	0,3	38	1,6
6	22 10,6	13	1	1	9	0 22,2	39	1 36,1	9	0,4	39	1,6
10	24 38,5	14	1	1	10	0 24,6	40	1 38,6	10	0,4	40	1,6
11	27 6,3	16	1	1	11	0 27,1	41	1 41,0	11	0,5	41	1,7
12	29 34,2	17	1	1	12	0 29,6	42	1 43,5	12	0,5	42	1,7
13	32 2,0	18	1	1	13	0 32,0	43	1 46,0	13	0,5	43	1,8
14	34 29,9	20	1	1	14	0 34,5	44	1 48,4	14	0,6	44	1,8
15	36 57,7	21	2	1	15	0 37,0	45	1 50,9	15	0,6	45	1,8
16	39 25,6	23	2	1	16	0 39,4	46	1 54,3	16	0,7	46	1,9
17	41 53,4	24	2	1	17	0 41,9	47	1 55,8	17	0,7	47	1,9
18	44 21,2	25	2	1	18	0 44,4	48	1 58,3	18	0,7	48	2,0
19	46 49,1	27	2	1	19	0 46,8	49	2 0,7	19	0,8	49	2,0
20	49 16,9	28	2	1	20	0 49,3	50	2 3,2	20	0,8	50	2,1
21	51 44,8	30	2	1	21	0 51,7	51	2 5,7	21	0,9	51	2,1
22	54 12,6	31	2	2	22	0 54,2	52	2 8,1	22	0,9	52	2,1
23	56 40,5	32	2	2	23	0 56,7	53	2 10,6	23	0,9	53	2,2
24	59 8,3	34	3	2	24	0 59,1	54	2 13,1	24	1,0	54	2,2
					25	1 1,6	55	2 15,5	25	,0	55	2,3
					26	1 4,1	56	2 18,0	26	1,1	56	2,3
					27	1 6,5	57	2 20,4	27	1,1	57	2,3
					28	1 9,0	58	2 22,9	28	1,1	58	2,4
					29	1 11,5	59	2 25,4	29	1,2	59	2,4
					30	1 13,9	60	2 27,8	30	1,2	60	2,5

For the Sun's Longitude. Equation of the Centre.

Equation of the Sun's Centre in the Elliptical Hypothesis.

Argu. ☉ mean Longit. —— Longit. ☉ Apogee.

S.	0			Diff.	1			Diff.	2			Diff.	S.
	——				——				——				
☌	°	′	″	′ ″	°	′	″	′ ″	°	′	″	′ ″	☌
0	0	0	0,0		0	56	43,5		1	38	59,5		30
				1 58,6				1 43,1				1 0,8	
1	0	1	58,6		0	58	26,6		1	40	0,3		29
				1 58,4				1 42,0				0 59,0	
2	0	3	57,0		1	0	8,6		1	40	59,3		28
				1 58,4				1 40,9				0 57,3	
3	0	5	55,4		1	1	49,5		1	41	56,6		27
				1 58,2				1 39,9				0 55,5	
4	0	7	53,6		1	3	29,4		1	42	52,1		26
				1 58,2				1 38,7				0 53,6	
5	0	9	51,8		1	5	8,1		1	43	45,7		25
				1 58,0				1 37,6				0 51,7	
6	0	11	49,8		1	6	45,7		1	44	37,4		24
				1 57,7				1 36,5				0 50,0	
7	0	13	47,5		1	8	22,2		1	45	27,4		23
				1 57,5				1 35,2				0 48,0	
8	0	15	45,0		1	9	57,4		1	46	15,4		22
				1 57,3				1 34,2				0 46,2	
9	0	17	42,3		1	11	31,6		1	47	1,6		21
				1 57,0				1 32,8				0 44,2	
10	0	19	39,3		1	13	4,4		1	47	45,8		20
				1 56,7				1 31,6				0 42,3	
11	0	21	36,0		1	14	36,0		1	48	28,1		19
				1 56,3				1 30,2				0 40,3	
12	0	23	32,3		1	16	6,2		1	49	8,4		18
				1 55,7				1 29,0				0 38,5	
13	0	25	28,0		1	17	35,2		1	49	46,9		17
				1 55,3				1 27,6				0 36,6	
14	0	27	23,3		1	19	2,8		1	50	23,5		16
				1 54,9				1 26,2				0 34,4	
15	0	29	18,2		1	20	29,0		1	50	57,9		15
				1 54,4				1 24,8				0 32,4	
16	0	31	12,6		1	21	53,8		1	51	30,3		14
				1 54,0				1 23,4				0 30,5	
17	0	33	6,6		1	23	17,2		1	52	0,8		13
				1 53,4				1 21,8				0 28,5	
18	0	35	0,0		1	24	39,0		1	52	29,3		12
				1 52,7				1 20,5				0 26,4	
19	0	36	52,7		1	25	59,5		1	52	55,7		11
				1 52,1				1 18,9				0 24.4	
20	0	38	44,8		1	27	18,4		1	53	20,1		10
				1 51,5				1 17,4				0 22.4	
21	0	40	36,3		1	28	35,8		1	53	42,5		9
				1 50,6				1 15,8				0 20,3	
22	0	42	26,9		1	29	51,6		1	54	2,8		8
				1 49,9				1 14,3				0 18,3	
23	0	44	16,8		1	31	5,9		1	54	21,1		7
				1 49,2				1 12,6				0 16,2	
24	0	46	6,0		1	32	18,5		1	54	37,3		6
				1 48,5				1 11,0				0 14,0	
25	0	47	54,5		1	33	29,5		1	54	51,3		5
				1 47,6				1 9,4				0 12,0	
26	0	49	42,1		1	34	38.9		1	55	3,3		4
				1 46,8				1 7,7				0 9,9	
27	0	51	28,9		1	35	46,6		1	55	13,2		3
				1 45,8				1 6,1				0 7,7	
28	0	53	14,7		1	36	52,7		1	55	20,9		2
				1 44,8				1 4,3				0 5,6	
29	0	54	59,5		1	37	57,0		1	55	26,5		1
				1 44,0				1 2,5				0 3,6	
30	0	56	43,5		1	38	59,5		1	55	30,1		0
	+				+				+				
	11				10				9				

For the Sun's Longitude. Equation of the Center.

Equation of the Sun's Center in the Elliptical Hypothesis.

Argu. ☉ mean Longit. —— Longit. ☉ Apogee.

S.	3			Diff.	4			Diff.	5			Diff.	S.
	——				——				——				
☌	°	′	″	′ ″	°	′	″	′ ″	°	′	″	′ ″	☌
0	1	55	30,1		1	41	5,6		0	58	49,7		30
				0 1,5				1 0,1				1 46,6	
1	1	55	31,6		1	40	5,5		0	57	3,1		29
				0 0,6				1 2,0				1 47,7	
2	1	55	31,0		1	39	3,5		0	55	15,4		28
				0 2,7				1 3,9				1 48,8	
3	1	55	28,3		1	37	59,6		0	53	26,6		27
				0 4,9				1 5,8				1 49,8	
4	1	55	23,4		1	36	53,8		0	51	36,8		26
				0 6,9				1 7,5				1 50,8	
5	1	55	16,5		1	35	46,3		0	49	46,0		25
				0 9,1				1 9,3				1 51,7	
6	1	55	7,4		1	34	37,0		0	47	54,3		24
				0 11,2				1 11,2				1 52,7	
7	1	54	56,2		1	33	25,8		0	46	1,6		23
				0 13,3				1 12,9				1 53,6	
8	1	54	42,9		1	32	12,9		0	44	8,0		22
				0 15,5				1 14,7				1 54,5	
9	1	54	27,4		1	30	58,2		0	42	13,5		21
				0 17,7				1 16,4				1 55,2	
10	1	54	9,7		1	29	41,8		0	40	18,3		20
				0 19,6				1 18,1				1 56,0	
11	1	53	50,1		1	28	23,7		0	38	22,3		19
				0 21,7				1 19,8				1 56,9	
12	1	53	28,4		1	27	3,9		0	36	25,4		18
				0 23,9				1 21,4				1 57,8	
13	1	53	4,5		1	25	42,5		0	34	27,9		17
				0 25,9				1 23,1				1 58,2	
14	1	52	38,6		1	24	19,4		0	32	29,7		16
				0 28,0				1 24,8				1 58,7	
15	1	52	10,6		1	22	54,6		0	30	31,0		15
				0 30,1				1 26,3				1 59,4	
16	1	51	40,5		1	21	28,3		0	28	31,6		14
				0 32,2				1 27,8				1 59,9	
17	1	51	8,3		1	20	0,5		0	26	31,7		13
				0 34,3				1 29,4				2 0,5	
18	1	50	34,0		1	18	31,1		0	24	31;2		12
				0 36,4				1 30,9				2 0,9	
19	1	49	57,6		1	17	0,2		0	22	30,3		11
				0 38,3				1 32,4				2 1,3	
20	1	49	19,3		1	15	27,8		0	20	29,0		10
				0 40,4				1 33,9				2 1,8	
21	1	48	38,9		1	13	53,9		0	18	27,2		9
				0 42,5				1 35,1				2 2,2	
22	1	47	56,4		1	12	18,8		0	16	25,0		8
				0 44,4				1 36,6				2 2,4	
23	1	47	12,0		1	10	42,2		0	14	22,6		7
				0 46,5				1 38,0				2 2,6	
24	1	46	25,5		1	9	4,2		0	12	20,0		6
				0 48,3				1 39,3				2 3,0	
25	1	45	37,2		1	7	24,9		0	10	17,0		5
				0 50,5				1 40,6				2 3,1	
26	1	44	46,7		1	5	44.3		0	8	13,9		4
				0 52,3				1 41,8				2 3,3	
27	1	43	54,4		1	4	2,5		0	6	10,6		3
				0 54,4				1 43,1				2 3,4	
28	1	43	0,0		1	2	19,4		0	4	7,2		2
				0 56,3				1 44,3				2 3,6	
29	1	42	3,7		1	0	35,1		0	2	3,6		1
				0 58,1				1 45,4				2 3,6	
30	1	41	5,6		0	58	49,7		0	0	0,0		0
	+				+				+				
	8				7				6				

For the ☉ Lon. Equa. of ☽

Arg. Num. I. ☽.

N.	0	100	200	300	400	N.
	+	+	+	+	+	
	″	″	″	″	″	
0	0,0	4,7	7,6	7,6	4,7	100
10	0,5	5,1	7,7	7,4	4,3	90
20	1,0	5,5	7,9	7,2	3,9	80
30	1,5	5,8	7,9	7,0	3,4	70
40	2,0	6,2	8,0	6,8	2,9	60
50	2,5	6,5	8,0	6,5	2,5	50
60	2,9	6,8	8,0	6,2	2,0	40
70	3,4	7,0	7,9	5,8	1,5	30
80	3,9	7,2	7,9	5,5	1,0	20
90	4,3	7,4	7,7	5,1	0,5	10
100	4,7	7,6	7,6	4,7	0,0	0
	—	—	—	—	—	
	900	800	700	600	500	

For the ☉ Lon. Equa. of ♃

Arg. Num. II. ♃.

N.	0	100	200	300	400	N.
	+	+	+	+	+	
	″	″	″	″	″	
0	0,0	5,6	7,5	5,3	2,2	100
10	0,6	6,1	7,3	4,9	1,9	90
20	1,2	6,4	7,2	4,6	1,7	80
30	1,8	6,6	7,0	4,3	1,4	70
40	2,5	6,9	6,8	4,0	1,2	60
50	3,1	7,1	6,7	3,6	1,0	50
60	3,7	7,3	6,5	3,3	0,8	40
70	4,2	7,4	6,2	3,0	0,6	30
80	4,7	7,4	5,9	2,8	0,4	20
90	5,2	7,5	5,5	2,5	0,2	10
100	5,6	7,5	5,3	2,2	0,0	0
	—	—	—	—	—	
	900	800	700	600	500	

For the ☉ Lon. Equa. of ♀.

Arg. Num. III. ♀.

N.	0	100	200	300	400	N.
	—	∓	+	+	+	
	″	″	″	″	″	
0	0,0	2,0	1,5	5,5	5,1	100
10	0,4	1,9	2,0	5,7	4,7	90
20	0,7	1,7	2,5	5,9	4,3	80
30	1,1	1,5	3,0	6,0	3,9	70
40	1,4	1,2	3,5	6,0	3,4	60
50	1,6	0,8	3,9	6,0	2,9	50
60	1,8	0,4	4,3	5,9	2,4	40
70	2,0	0,0	4,7	5,8	1,8	30
80	2,1	0,5	5,0	5,6	1,2	20
90	2,1	1,0	5,3	5,4	0,6	10
100	2,0	1,5	5,5	5,1	0,0	0
	+	∓	—	—	—	
	900	800	700	600	500	

Of a Point in the Equinoctial.

Arg Num. IV. ☊.

N.	0	100	200	300	400	N.
	+	+	+	+	+	
	′	″	″	″	″	
0	0,0	10,6	17,1	17,1	10,6	100
10	1,2	11,5	17,4	16,7	9,7	90
20	2,3	12,3	17,7	16,3	8,7	80
30	3,4	13,1	17,9	15,8	7,7	70
40	4.5	13,9	18,0	15,2	6,6	60
50	5,6	14,6	18,0	14,6	5,6	50
60	6,6	15,2	18,0	13,9	4,5	40
70	7,7	15,8	17,9	13,1	3,4	30
80	8,7	16,3	17,7	12,3	2,3	20
90	9,7	16,7	17,4	11,5	1,2	10
100	10,6	17,1	17,1	10,6	0,0	0
	—	—	—	—	—	
	900	800	700	600	500	

For the Logarithm of the Sun's distance from the Earth.

Logarithm of the Sun's distance from the earth in the Elliptic Hypothesis.

Argu. ☉ mean Longit. —— Longit. ☉ Apo.

S.	0		1		2		S.
	Log. dist.	Diff.	Log. dist.	Diff.	Log. dist.	Diff.	
0	Part.	Part.	Part.	Part.	Part.	Part.	0
0	0.007236	1	0.006303	62	0.003724	108	30
1	0.007235	3	0.006241	64	0.003616	109	29
2	0.007232	5	0.006177	65	0.003507	110	28
3	0.007227	7	0.006112	67	0.003397	112	27
4	0.007220	10	0.006045	69	0.003285	112	26
5	0.007210	12	0.005976	71	0.003173	113	25
6	0.007198	14	0.005905	73	0.003060	114	24
7	0.007184	16	0.005832	74	0.002946	115	23
8	0.007168	17	0.005758	76	0.002831	116	22
9	0.007151	20	0.005682	78	0.002715	118	21
10	0.007131	22	0.005604	80	0.002597	119	20
11	0.007109	24	0.005524	81	0.002478	119	19
12	0.007085	26	0.005443	83	0.002359	119	18
13	0.007059	29	0.005360	84	0.002240	120	17
14	0.007030	31	0.005276	86	0.002120	121	16
15	0.006999	33	0.005190	88	0.001999	122	15
16	0.006966	35	0.005102	89	0.001877	122	14
17	0.006931	36	0.005013	91	0.001755	123	13
18	0.006895	38	0.004922	92	0.001632	124	12
19	0.006857	40	0.004830	94	0.001508	124	11
20	0.006817	42	0.004736	95	0.001384	125	10
21	0.006775	44	0,004641	97	0.001259	125	9
22	0.006731	47	0.004544	98	0.001134	125	8
23	0.006684	49	0.004446	99	0.001009	125	7
24	0.006635	51	0.004347	100	0.000884	126	6
25	0.006584	53	0.004247	102	0.000758	126	5
26	0.006531	54	0.004145	103	0.000632	127	4
27	0.006477	56	0.004042	105	0.000505	127	3
28	0.006421	58	0.003937	106	0.000378	127	2
29	0.006363	60	0.093831	107	0.000251	128	1
30	0.006303		0.003724		0.000123		0
S.	11		10		9		S.

S.	3		4		5		S.
	Log. dist.	Diff.	Log. dist.	Diff.	Log. dist.	Diff.	
0	Part.	Part.	Part.	Part.	Part.	Part.	0
0	0.000123	127	9.996430	112	9.993664	66	30
1	9.999996	128	9.996318	111	9.993598	63	29
2	9.999868	127	9.996207	110	9.993535	61	28
3	9.999741	127	9.996097	110	9.993474	59	27
4	9.999614	127	9.995987	108	9.993415	58	26
5	9.999487	127	9.995879	107	9.993357	55	25
6	9.999360	127	9.995772	105	9.993302	53	24
7	9.999233	127	9.995667	104	9.993249	51	23
8	9.999106	127	9.995563	103	9.993198	49	22
9	9.998979	127	9.995460	102	9.993149	47	21
10	9.998852	126	9.995358	100	9.993102	45	20
11	9.998726	126	9.995158	98	9.993057	43	19
12	9.998600	126	9.995160	97	9.993014	40	18
13	9.998474	126	9.995063	96	9.992974	37	17
14	9.998348	125	9.994967	94	9.992937	35	16
15	9.998223	125	9.994873	93	9.992902	34	15
16	9.998098	124	9.994780	91	9.992868	32	14
17	9.997974	123	9.994689	90	9.992836	29	13
18	9.997851	122	9.994599	88	9.992807	26	12
19	9.997729	121	9.994511	86	9.992781	24	11
20	9.997608	121	9.994425	83	9.992757	22	10
21	9.997487	120	9.994342	82	9.992735	20	9
22	9.997367	120	9.994260	81	9.992715	18	8
23	9.997247	119	9.994179	80	9.992697	15	7
24	9.997128	119	9.994099	78	9.992682	13	6

S.	3		4		5		S.
	Log. dist.	Diff.	Log. dist.	Diff.	Log. dist.	Diff.	
0	Part.	Part.	Part.	Part.	Part.	Part.	0
25	9.997009	118	9.994021	75	9.992669	11	5
26	9.996891	117	9.993946	73	9.992658	8	4
27	9.996774	116	9.993873	71	9.992850	5	3
28	9.996658	115	9.993802	70	9.992645	3	2
29	9.996543	113	9.993732	68	9.992642	1	1
30	9.996430		9.993664		9.992641		0
S.	8		7		6		S.

For log. of the ☉ dist. from the Earth. Equa. ☽.

Arg. Num. I. ☽.

	0	100	200	300	400	
	+	+	±	—	—	
N.	P.	P.	P.	P.	P.	N.
0	17	14	5	5	14	100
10	17	13	4	6	14	90
20	17	13	3	7	15	80
30	16	12	2	8	15	70
40	16	11	1	9	16	60
50	16	10	0	10	16	50
60	16	9	1	11	16	40
70	15	8	2	12	16	30
80	15	7	3	13	17	20
90	14	6	4	13	17	10
100	14	5	5	14	17	0
	+	+	±	—	—	
	900	800	700	600	500	

For log. of the ☉ dist. from the Earth. Equa. ☿.

Arg. Num. II. ☿.

	0	100	200	300	400	
	+	+	+	—	—	
N.	P.	P.	P.	P.	P.	N.
0	4	4	4	0	6	100
10	4	5	4	0	6	90
20	4	5	4	1	7	80
30	4	5	3	2	8	70
40	4	5	3	2	8	60
50	4	5	3	3	9	50
60	4	5	2	4	9	40
70	4	4	2	4	9	30
80	4	4	1	5	9	20
90	4	4	1	6	9	10
100	4	4	0	6	9	0
	+	+	+	—	—	
	900	800	700	600	500	

For log. of the ☉ dist. from the Earth. Equa. ♀.

Arg. Num. III. ♀.

	0	100	200	300	400	
	+	—	—	∓	+	
N.	P.	P.	P.	P.	P.	N.
0	4	0	5	3	3	100
10	4	1	5	3	3	90
20	4	1	5	2	4	80
30	3	2	5	2	4	70
40	3	3	5	1	5	60
50	3	3	4	0	5	50
60	2	4	4	1	5	40
70	2	4	4	2	5	30
80	1	4	4	2	6	20
90	1	5	3	3	6	10
100	0	5	3	3	6	0
	+	—	—	∓	+	
	900	800	700	600	500	

For log. of the ☉ dist. from the Earth. Equa. ♂.

Arg. Num. IV. ♂.

	0	100	200	00	400	
	+	+	±	—	—	
N	//	//	//	//	//	N.
0	9,6	7,8	3,0	3,0	7,8	100
10	9,6	7,4	2,4	3,5	8,1	90
20	9,5	7,0	1,8	4,1	8,4	80
30	9,4	6,6	1,2	4,6	8,7	70
40	9,3	6,1	0,6	5,2	8,9	60
50	9,1	5,7	0,0	5,7	9,1	50
60	8,9	5,2	0,6	6,1	9,3	40
70	8,7	4,6	1,2	6,6	9,4	30
80	8,4	4,1	1,8	7,0	9,5	20
90	8,1	3,5	2,4	7,4	9,6	10
100	7,8	3,0	3,0	7,8	9,6	0
	+	+	±	—	—	
	900	800	700	600	500	

For the apparent semidiameter and hourly motion of the Sun.

Argument. ☉ mean Longit. —— Longit. ☉ Apogee.

S.	0		1		2		3		4		5		S.
	Sem. ☉	H. M. ☉	Sem. ☉	H. M. ☉	Sem. ☉	H. M. ☉	Sem. ☉	H. M. ☉	Sem. ☉	H. M. ☉	Sem. ☉	H. M. ☉	
o	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	o
0	15 46,9	2 23,0	15 48,9	2 23,6	15 54,6	2 25,3	16 2,5	2 27,7	16 10,7	2 30,2	16 16,9	2 32,2	30
1	15 46,9	2 23,0	15 49,0	2 23,6	15 54,8	2 25,3	16 2,8	2 27,8	16 11,0	2 30,3	16 17,1	2 32,2	29
2	15 46,9	2 23,0	15 49,2	2 23,7	15 55,1	2 25,4	16 3,1	2 27,9	16 11,2	2 30,4	16 17,2	2 32,3	28
3	15 46,9	2 23,0	15 49,3	2 23,7	15 55,3	2 25,4	16 3,3	2 28,0	16 11,5	2 30,4	16 17,4	2 32,3	27
4	15 46,9	2 23,0	15 49,5	2 23,8	15 55,6	2 25,5	16 3,6	2 28,1	16 11,7	2 30,5	16 17,5	2 32,3	26
5	15 46,9	2 23,0	15 49,6	2 23,8	15 55,8	2 25,6	16 3,9	2 28,2	16 12,0	2 30,6	16 17,6	2 32,4	25
6	15 47,0	2 23,0	15 49,8	2 23,9	15 56,1	2 25,6	16 4,2	2 28,3	16 12,2	2 30,7	16 17,8	2 32,4	24
7	15 47,0	2 33,0	15 49,9	2 23,6	15 56,3	2 25,7	16 4,5	2 28,4	16 12,5	2 30,8	12 17,9	2 32,5	23
8	15 47,0	2 23,0	15 50,1	2 24,0	15 56,6	2 25,8	16 4,7	2 28,5	16 12,7	2 30,8	16 18,0	2 32,5	22
9	15 47,1	2 23,0	15 50,3	2 24,0	15 56,8	2 25,9	16 5,0	2 28,5	16 12,9	2 30,9	16 18,1	2 32,5	21
10	15 47,1	2 23,0	15 50,5	2 24,1	15 57,1	2 26,0	16 5,3	2 28,6	16 13,1	2 31,0	16 18,2	2 32,6	20
11	15 47,1	2 23,0	15 50,7	2 24,1	15 57,4	2 26,1	16 5,6	2 28,7	16 13,3	2 31,1	16 18,3	2 32,6	19
12	15 47,2	2 23,1	15 50,8	2 24,2	15 57,6	2 26,1	16 5,9	2 28,8	16 13,6	2 31,1	16 18,4	2 32,7	18
13	15 47,2	2 23,1	15 51,0	2 24,3	15 57,9	2 26,2	16 6,1	2 28,9	16 13,8	2 31,2	16 18,5	2 32,7	17
14	15 47,3	2 23,1	15 51,2	2 24,3	15 58,1	2 26,3	16 6,4	2 28,9	16 14,0	2 31,3	16 18,6	2 32,7	16
15	15 47,4	2 23,1	15 51,4	2 24,4	15 58,4	2 26,4	16 6,7	2 29,0	16 14,2	2 31,4	16 18,7	2 32,8	15
16	15 47,4	2 23,1	15 51,6	2 24,5	15 58,7	2 26,5	16 7,0	2 29,1	16 14,4	2 31,5	16 18,8	2 32,8	14
17	15 47,5	2 23,2	15 51,8	2 24,5	15 58,9	2 26,5	16 7,3	2 29,2	16 14,6	2 31,5	16 18,9	2 32,8	13
18	15 47,6	2 23,2	15 52,0	2 24,6	15 59,2	2 26,6	16 7,5	2 29,2	16 14,8	2 31,6	16 18,9	2 32,8	12
19	15 47,7	2 23,2	15 52,2	2 24,6	15 59,4	2 26,7	16 7,8	2 29,3	16 15,0	2 31,7	16 19,0	2 32,8	11
20	15 47,8	2 23,2	15 52,4	2 24,7	15 59,7	2 26,8	16 8,1	2 29,4	16 15,2	2 31,7	16 19,0	2 32,8	10
21	15 47,6	2 23,3	15 52,6	2 24,7	16 0,0	2 26,9	16 8,4	2 29,5	16 15,4	2 31,8	16 19,1	2 32,8	9
22	15 48,0	2 23,3	15 52,8	2 24,8	16 0,3	2 27,0	16 8,6	2 29,6	16 15,6	2 31,8	16 19,1	2 32,8	8
23	15 48,1	2 23,3	15 53,0	2 24,8	16 0,5	2 27,1	16 8,9	2 29,7	16 15,8	2 31,9	16 19,1	2 32,9	7
24	15 48,2	2 23,4	15 53,2	2 24,9	16 0,8	2 27,2	16 9,2	2 29,7	16 16,0	2 32,0	16 19,2	2 32,9	6
25	15 48,3	2 23,4	15 53,4	2 25,0	16 1,1	2 27,3	16 9,5	2 29,8	16 16,1	2 32,0	16 19,2	2 32,9	5
26	15 48,4	2 23,4	15 53,6	2 25,1	16 1,4	2 27,3	16 9,8	2 29,9	16 16,3	2 32,1	16 19,2	2 32,9	4
27	15 48,5	2 23,5	15 53,8	2 25,1	16 1,7	2 27,4	16 10,0	2 30,0	16 16,4	2 32,1	16 19,2	2 32,9	3
28	15 48,6	2 23,5	15 54,1	2 25,2	16 1,9	2 27,5	16 10,3	2 30,1	16 16,6	2 32,2	16 19,2	2 32,9	2
29	15 48,8	2 23,6	15 54,3	2 25,2	16 2,2	2 27,6	16 10,5	2 30,1	16 16,8	2 32,2	16 19,3	2 32,9	1
30	15 48,9	2 23,6	15 54,6	2 25,3	16 2,5	2 27,7	16 10,7	2 30,2	16 16,9	2 32,2	16 19,3	2 32,9	0
S.	11		10		9		8		7		6		S.

For right Ascension of a Point of the Ecliptic. Reduction of the Ecliptic to the Equator.

According to the obliquity of the Ecliptic 23° 28′ 15″,
With the change of reduction for the change of the obliquity one minute.

Argument. Longitude of a point in the Ecliptic.

S.	0 6				1 7				2 8				S.	
	——		Diff.	Change.	——		Diff.	Change.	——		Diff.	Change.		
o	′	o ′ ″	′ ″	″	o ′ ″		′ ″	″	o ′ ″		′ ″	″	o	′
0	0	0 0 0,0	2 28,9	0,0	2 5 42,4		1 19,7	10,8	2 11 14,7		1 15,3	11,7	30	0
0	30	0 2 28,9	2 28,9	0,2	2 7 2,1		1 17,5	10,9	2 9 59,4		1 17,7	11,6	29	30
1	0	0 4 57,8	2 28,8	0,4	2 8 19,6		1 15,3	11,0	2 8 41,6		1 20,4	11,5	29	0
1	30	0 7 26,6	2 28,7	0,6	2 9 34,9		1 13,0	11,1	2 7 21,2		1 22,8	11,4	28	30
2	0	0 9 55,3	2 28,5	0,8	2 10 47,9		1 10,8	11,2	2 5 58,4		1 25,2	11,3	28	0
2	30	0 12 23,8	2 28,3	1,0	2 11 58,7		1 8,6	11,3	2 4 33,2		1 27,8	11,2	27	30
3	0	0 14 52,1	2 28,1	1,3	2 13 7,3		1 6,3	11,5	2 3 5,4		1 30,1	11,1	27	0
3	30	0 17 20,2	2 27,8	1,5	2 14 13,6		1 4,0	11,6	2 1 35,3		1 32,6	10,9	26	30
4	0	0 19 48,0	2 27,5	1,7	2 15 17,6		1 1,5	11,7	2 0 2,7		1 35,0	10,8	26	0
4	30	0 22 15,5	2 27,1	1,9	2 16 19,1		0 59,1	11,8	1 58 27,7		1 37,2	10,7	25	30
5	0	0 24 42,6	2 26,7	2,1	2 17 18,2		0 56,9	11,8	1 56 50,5		1 39,6	10,5	25	0
5	30	0 27 9,3	2 26,3	2,3	2 18 15,1		0 54,4	11,9	1 55 10,9		1 41,9	10,4	24	30
6	0	0 29 35,6	2 25,9	2,5	2 19 9,5		0 51,9	12,0	1 53 29,0		1 44,2	10,2	24	0
6	30	0 32 1,5	2 25,3	2,7	2 20 1,4		0 49,6	12,1	1 51 44,8		1 46,3	10,1	23	30
7	0	0 34 26,8	2 24,7	2,9	2 20 51,0		0 47,1	12,2	1 49 58,5		1 48,5	9,9	23	0
7	30	0 36 51,5		3,1	2 21 38,1			12,2	1 48 10,0			9,8	22	30

For right Aſcenſion of a Point of the Ecliptic. — Reduction of the Ecliptic to the Equator.

According to the obliquity of the Ecliptic, 23° 28′ 15″,

With the change of reduction for the change of the Obliquity one minute.

Argument. — Longitude of a point in the Ecliptic.

S.	0	6		1	7		2	8		S.
	——	Diff.	Change.	——	Dff.	Change.	——	Diff.	Change.	
° ′	° ′ ″	′ ″	″	° ′ ″	′ ″	″	° ′ ″	′ ″	″	° ′
8 0	0 39 15,6	2 25,8	3,3	2 22 22,6	0 44,5	12,3	1 46 19,3	1 50,7	9,6	22 0
8 30	0 41 39,1	2 23,5	3,5	2 23 4,6	0 42,0	12,4	1 44 26,5	1 52,8	9,4	21 30
9 0	0 44 2,0	2 22,9	3,7	2 23 44,1	0 39,5	12,5	1 42 31,5	1 55,0	9,3	21 0
9 30	0 46 24,2	2 22,2	3,9	2 24 21,0	0 36,9	12,5	1 40 34,5	1 57,0	9,1	20 30
10 0	0 48 45,5	2 21,3	4,1	2 24 55,5	0 34,5	12,6	1 38 35,5	1 59,0	8,9	20 0
10 30	0 51 6,1	2 20,6	4,3	2 25 27,3	0 31,8	12,6	1 36 34,5	2 1,0	8,8	19 30
11 0	0 53 25,9	2 19,8	4,5	2 25 56,6	0 29,3	12,7	1 34 31,5	2 3,0	8,6	19 0
11 30	0 55 44,8	2 18,9	4,7	2 26 23,2	0 26,6	12,7	1 32 26,7	2 4,8	8,4	18 30
12 0	0 58 2,8	2 18,0	4,9	2 26 47,2	0 24,0	12,8	1 30 19,9	2 6,8	8,2	18 0
12 30	1 0 19,9	2 17,1	5,1	2 27 8,7	0 21,5	12,8	1 28 11,2	2 8,7	8,0	17 30
13 0	1 2 35,9	2 16,0	5,3	2 27 27,3	0 18,6	12,9	1 26 1,0	2 10,2	7,8	17 0
13 30	1 4 50,9	2 15,0	5,5	2 27 43,3	0 16,0	12,9	1 23 48,9	2 12,1	7,6	16 30
14 0	1 7 4,9	2 14,0	5,7	2 27 56,8	0 13,5	12,9	1 21 35,1	2 13,1	7,4	16 0
14 30	1 9 17,8	2 12,9	5,8	2 28 7,6	0 10,8	13,0	1 19 19,7	2 15,4	7,2	15 30
15 0	1 11 29,6	2 11,8	6,0	2 28 15,6	0 8,0	13,0	1 17 2,6	2 17,1	7,0	15 0
15 30	1 13 40,2	2 10,6	6,2	2 28 20,9	0 5,3	13,0	1 14 44,0	2 18,6	6,8	14 30
16 0	1 15 49,6	2 9,4	6,4	2 28 23,9	0 2,7	13,0	1 12 23,7	2 20,3	6,6	14 0
16 30	1 17 57,8	2 8,2	6,6	2 28 23,6	0 0,0	13,0	1 10 1,9	2 21,8	6,4	13 30
17 0	1 20 4,6	2 6,8	6,8	2 28 20,7	0 2,9	13,0	1 7 38,9	2 23,0	6,2	13 0
17 30	1 22 10,1	2 5,5	7,0	2 28 15,0	0 5,7	13,0	1 5 14,5	2 24,5	6,0	12 30
18 0	1 24 14,4	2 4,3	7,1	2 28 6,9	0 8,1	13,0	1 2 48,6	2 25,9	5,7	12 0
18 30	1 26 17,3	2 2,9	7,3	2 27 56,1	0 10,8	13,0	1 0 21,4	2 27,2	5,5	11 30
19 0	1 28 18,7	2 1,4	7,5	2 27 42,3	0 13,8	13,0	0 57 53,1	2 28,3	5,3	11 0
19 30	1 30 18,7	2 0,0	7,6	2 27 25,8	0 16,5	13,0	0 55 23,5	2 29,6	5,1	10 30
20 0	1 32 17,1	1 58,4	7,8	2 27 6,6	0 19,2	13,0	0 52 52,8	2 30,7	4,8	10 0
20 30	1 34 14,1	1 57,0	8,0	2 26 44,7	0 21,9	12,9	0 50 21,0	2 31,8	4,6	9 30
21 0	1 36 9,4	1 55,3	8,2	2 26 20,1	0 24,6	12,9	0 47 48,1	2 32,9	4,4	9 0
21 30	1 38 3,2	1 53,8	8,3	2 25 52,6	0 27,5	12.9	0 45 14,3	2 33,8	4,2	8 30
22 0	1 39 55,4	1 52,2	8,5	2 25 22,6	0 30,0	12,9	0 42 39,5	2 34,8	3,9	8 0
22 30	1 41 45,8	1 50,4	8,7	2 24 49,9	0 32,7	12,8	0 40 3,8	2 35,7	3,6	7 30
23 0	1 43 34,7	1 48,9	8,8	2 24 14,2	0 35,7	12,8	0 37 27,4	2 36,4	3,4	7 0
23 30	1 45 21,8	1 47,1	9,0	2 23 35,8	0 38,4	12,7	0 34 50,2	2 37,2	3,1	6 30
24 0	1 47 7,1	1 45,3	9,1	2 22 54,9	0 40,9	12,7	0 32 12,1	2 38,1	2,9	6 0
24 30	1 48 50,6	1 43,5	9,3	2 22 11,3	0 43,6	12,6	0 29 33,4	2 38,7	2,7	5 30
25 0	1 50 32,3	1 41,7	9,4	2 21 24,8	0 46,5	12,6	0 26 54,2	2 39,2	2,5	5 0
25 30	1 52 12,2	1 39,9	9,6	2 20 35,6	0 49,2	12,5	0 24 14,5	2 39,7	2,2	4 30
26 0	1 53 50,1	1 37,9	9,7	2 19 43,9	0 51,7	12,4	0 21 34,1	2 40,4	2,0	4 0
26 30	1 55 26,1	1 36,0	9,9	2 18 49,6	0 54,3	12,4	0 18 53,3	2 40,8	1,8	3 30
27 0	1 57 0,3	1 34,2	10,0	2 17 52,4	0 57,2	12,3	0 16 12,1	2 41,2	1,5	3 0
27 30	1 58 32,4	1 32,1	10,1	2 16 52,6	0 59,8	12,2	0 13 30,6	2 41,5	1,3	2 30
28 0	2 0 2,5	1 30,1	10,3	2 15 50,2	1 2,4	12,1	0 10 48,8	2 41,8	1,0	2 0
28 30	2 1 30,6	1 28,1	10,4	2 14 45,2	1 5,0	12,0	0 8 6,8	2 42,0	0,7	1 30
29 0	2 2 56,6	1 26,0	10,5	2 13 37,7	1 7,5	11,9	0 5 24,6	2 42,2	0,5	1 0
29 30	2 4 20,6	1 24,0	10,7	2 12 27,5	1 10,2	11,8	0 2 42,3	2 42,3	0,3	0 30
30 0	2 5 42,4	1 21,8	10,8	2 11 14,7	1 12,8	11,7	0 0 0,0	2 42,3	0,0	0 0
	+			+			+			
S.	5	11		4	10		3	9		S.

Declination of the Points of the Ecliptic.

According to the Obliquity of the Ecliptic, 23°. 28′. 15″.
With the Change of Reduction, for the Change of the Obliquity, one Minute.

Argument. Longitude of the Point in the Ecliptic.

S.	0 + 6 —						1 + 7 —						2 + 8 —						S.	
	Declination.			Diff.		Change.	Declination.			Diff.		Change.	Declination.			Diff.		Change.		
°	°	′	″	′	″	″	°	′	″	′	″	″	°	′	″	′	″	″	°	′
0	0	0	0	0,0	11 57,0	0,0	11	29	12,3	10 32,1		28,1	20	10	37,4	6 19,2		50,8	30	0
0	30	0	11	57,0	11 56,8	0,5	11	39	44,4	10 29,3		28,5	20	16	56,6	6 13,5		51,1	29	30
1	0	0	23	53,8	11 56,7	1,0	11	50	13,7	10 26,4		29,0	20	23	10,1	6 8,0		51,4	29	0
1	30	0	35	50,5	11 56,6	1,4	12	0	40,1	10 23,5		29,4	20	29	18,1	6 2,4		51,7	28	30
2	0	0	47	47,1	11 56,4	1,9	12	11	3,6	10 20,5		29,9	20	35	20,5	5 56,7		51,9	28	0
2	30	0	59	43,5	11 56,3	2,4	12	21	24,1	10 17,4		30,3	20	41	17,2	5 51,0		52,2	27	30
3	0	1	11	39,8	11 55,9	2,9	12	31	41,5	10 14,3		30,7	20	47	8,2	5 45,2		52,4	27	0
3	30	1	23	35,7	11 55,6	3,4	12	41	55,8	10 11,3		31,2	20	52	53,4	5 39,5		52,7	26	30
4	0	1	35	31,3	11 55,3	3,8	12	52	7,1	10 8,1		31,6	20	58	32,9	5 33,7		53,0	26	0
4	30	1	47	26,6	11 54,8	4,3	13	2	15,2	10 4,8		32,0	21	4	6,6	5 27,8		53,2	25	30
5	0	1	59	21,4	11 54,5	4,8	13	12	20,0	10 1,5		32,4	21	9	34,4	5 21,9		53,5	25	0
5	30	2	11	15,9	11 53,8	5,3	13	22	21,5	9 58,3		32,8	21	14	56,3	5 16,0		53,7	24	30
6	0	2	23	9,7	11 53,3	5,8	13	32	19,8	9 54,9		33,3	21	20	12,3	5 10,1		54,0	24	0
6	30	2	35	3,0	11 52,7	6,2	13	42	14,7	9 51,5		33,7	21	25	22,4	5 4,1		54,2	23	30
7	0	2	46	55,7	11 52,2	6,7	13	52	6,2	9 48,0		34,1	21	30	26,5	4 58,2		54,5	23	0
7	30	2	58	47,9	11 51,3	7,2	14	1	54,2	9 44,4		34,5	21	35	24,7	4 51,9		54,7	22	30
8	0	3	10	39,2	11 50,7	7,7	14	11	38,6	9 40,8		35,0	21	40	16,6	4 45,9		54,9	22	0
8	30	3	22	29,9	11 49,8	8,2	14	21	19,4	9 37,5		35,4	21	45	2,5	4 39,8		55,2	21	30
9	0	3	34	19,7	11 48,9	8,6	14	30	56,9	9 33,7		35,8	21	49	42,3	4 33,6		55,4	21	0
9	30	3	46	8,6	11 48,3	9,1	14	40	30,6	9 30,0		36,2	21	54	15,9	4 27,6		55,6	20	30
10	0	3	57	56,9	11 47,3	9,6	14	50	0,6	9 26,1		36,6	21	58	43,5	4 21,3		55,8	20	0
10	30	4	9	44,2	11 46,2	10,1	14	59	26,7	9 22,5		37,0	22	3	4,8	4 15,1		56,0	19	30
11	0	4	21	30,4	11 45,3	10,6	15	8	49,2	9 18,6		37,4	22	7	19,9	4 9,0		56,2	19	0
11	30	4	33	15,7	11 44,2	11,0	15	18	7,8	9 14,8		37,8	22	11	28,9	4 2,4		56,4	18	30
12	0	4	44	59,9	11 43,1	11,5	15	27	22,6	9 10,7		38,2	22	15	31,3	3 56,1		56,6	18	0
12	30	4	56	43,0	11 41,9	12,0	15	36	33,3	9 6,8		38,6	22	19	27,4	3 49,9		56,8	17	30
13	0	5	8	24,9	11 40,8	12,4	15	45	40,1	9 2,8		39,0	22	23	17,3	3 43,5		57,0	17	0
13	30	5	20	5,7	11 39,5	12,9	15	54	42,9	8 58,7		39,4	22	27	0,8	3 37,2		57,1	16	30
14	0	5	31	45,2	11 38,2	13,4	16	3	4,6	8 54,6		39,8	22	30	38,0	3 30,6		57,3	16	0
14	30	5	43	23,4	11 36,8	13,9	16	12	36,2	8 50,4		40,2	22	34	8,6	3 24,3		57,5	15	30
15	0	5	55	0,2	11 35,6	14,3	16	21	26,6	8 46,2		40,6	22	37	32,9	3 17,7		57,6	15	0
15	30	6	6	35,8	11 34,0	14,8	16	30	12,8	8 42,0		41,0	22	40	50,6	3 11,4		57,8	14	30
16	0	6	18	9,8	11 32,6	15,3	16	38	54,8	8 37,6		41,4	22	44	2,0	3 4,8		57,9	14	0
16	30	6	29	42,4	11 31,0	15,7	16	47	32,4	8 33,3		41,7	22	47	6,8	2 58,2		58,0	13	30
17	0	6	41	13,4	11 29,5	16,2	16	56	5,7	8 28,8		42,1	22	50	5,0	2 51,8		58,2	13	0
17	30	6	52	42,9	11 27,9	16,7	17	4	34,5	8 24,5		42,5	22	52	56,8	2 45,1		58,3	12	30
18	0	7	4	10,8	11 26,1	17,1	17	12	59,0	8 20,4		42,9	22	55	41,9	2 38,5		58,4	12	0
18	30	7	15	36,9	11 24,6	17,6	17	21	19,4	8 15,0		43,2	22	58	20,4	2 31,9		58,6	11	30
19	0	7	27	1,5	11 22,6	18,1	17	29	34,4	8 10,8		43,6	23	0	52,3	2 25,3		58,7	11	0
19	30	7	38	24,1	11 21,0	18,5	17	37	45,2	8 6,3		43,9	23	3	17,6	2 18,7		58,8	10	30
20	0	7	49	45,1	11 19,2	19,0	17	45	51,5	8 1,5		44,3	23	5	36,3	2 12,0		58,9	10	0
20	30	8	1	4,3	11 17,1	19,4	17	53	53,0	7 56,8		44,6	23	7	48,3	2 5,3		59,0	9	30
21	0	8	12	21,4	11 15,3	19,9	18	1	49,8	7 52,1		45,0	23	9	53,6	1 58,6		59,1	9	0
21	30	8	23	36,7	11 13,2	20,4	18	9	41,9	7 47,3		45,3	23	11	52,2	1 52,0		59,2	8	30
22	0	8	34	49,9	11 11,1	20,8	18	17	29,2	7 42,4		45,7	23	13	44,2	1 45,2		59,3	8	0
22	30	8	46	1,0	11 9,2	21,3	18	25	11,6	7 37,6		46,0	23	15	29,4	1 38,5		59,4	7	30
23	0	8	57	10,2	11 7,1	21,7	18	32	49,2	7 32,6		46,4	23	17	7,9	1 31,7		59,5	7	0
23	30	9	8	17,3	11 4,7	22,2	18	40	21,8	7 27,6		46,7	23	18	39,6	1 25,0		59,5	6	30
24	0	9	19	22,0	11 2,6	22,7	18	47	49,4	7 22,7		47,1	23	20	4,6	1 18,2		59,6	6	0
24	30	9	30	24,6	11 0,2	23,2	18	55	12,1	7 17,5		47,4	23	21	22,8	1 11,5		59,6	5	30
25	0	9	41	24,8	10 58,0	23,6	19	2	29,6	7 12,4		47,7	23	22	34,3	1 4,7		59,7	5	0
25	30	9	52	22,8	10 55,6	24,1	19	9	42,0	7 7,3		48,0	23	23	39,0	0 57,9		59,7	4	30
26	0	10	3	18,4	10 53,2	24,5	19	16	49,3	7 2,1		48,4	23	24	36,9	0 51,1		59,8	4	0
26	30	10	14	11,6	10 50,7	25,0	19	23	51,4	6 56,9		48,7	23	25	28,0	0 44,3		59,8	3	30
27	0	10	25	2,3	10 48,3	25,5	19	30	48,3	6 51,6		49,0	23	26	12,3	0 37,5		59,8	3	0
27	30	10	35	50,6	10 45,6	25,9	19	37	39,9	6 46,3		49,3	23	26	49,8	0 30,6		59,9	2	30
28	0	10	45	36,2	10 42,9	26,3	19	44	26,2	6 41,1		49,6	23	27	20,4	0 23,9		59,9	2	0
28	30	10	57	19,1	10 40,5	26,8	19	51	7,3	6 35,5		49,9	23	27	44,3	0 17,1		59,9	1	30
29	0	11	7	59,6	10 37,8	27,2	19	57	42,8	6 30,0		50,2	23	28	1,4	0 10,2		60,0	1	0
29	30	11	18	37,4	10 34,9	27,7	20	4	12,8	6 24,6		50,5	23	28	11,6	0 3,4		60,0	0	30
30	0	11	29	12,3		28,1	20	10	37,4			50,8	23	28	15,0			60,0	0	0
S.	5 + 11 —						4 + 10 —						3 + 9 —						S.	

ASTRONOMICAL REFRACTIONS.

Sun's parallax, In the vertical circle.

For the height of the barometer 28°. 0′ Paris, and the graduation of Reaumur's thermometer, 10°. above freezing, with variations for 10 lines in the height of the barometer, and 10 degrees of the thermometer.*

Dist. from vert.	Sun's Parallax	Dist. from vert.	Refract. for bar. 28d th. + 10	Var. for 1 lin. bar.	Var. for 10 d. ther.	Dist. from vert.	Refract. for bar 28d 0′ th. +10	Var. for 1 lin. bar.	Var. for 10 d. ther.	Dist. from vert.	Refract. for bar. 28d 0′ ther. +10.	Var. for 1 lin. bar.	Var. for 10 d. ther.
°	″	°	′ ″	″	″	°	′ ″	″	″	°	″	″	″
0	0,0	0	0 0,0	0,0	0,0	30	0 33,1	1,0	1,5	60	1 39,0	2,9	4,5
3	0,4	1	0 1,0	0,0	0,0	31	0 34,4	1,0	1,5	61	1 43,2	3,0	4,7
6	0,9	2	0 2,0	0,1	0,1	32	0 35,8	1,1	1,6	62	1 47,6	3,1	4,9
9	1,4	3	0 3,0	0,1	0,1	33	0 37,2	1,1	1,7	63	1 52,3	3,2	5,1
12	1,8	4	0 4,0	0,1	0,2	34	0 38,7	1,2	1,7	64	1 57,2	3,4	5,3
15	2,3	5	0 5,0	0,2	0,2	35	0 40,2	1,2	1,8	65	2 2,4	3,5	5,6
18	2,7	6	0 6,1	0,2	0,2	36	0 41,7	1,2	1,9	66	2 8,0	3,7	5,9
21	3,1	7	0 7,1	0,2	0,3	37	0 43,3	1,3	2,0	67	2 14,2	4,0	6,3
24	3,6	8	0 8,1	0,2	0,3	38	0 44,9	1,3	2,0	68	2 20,9	4,2	6,6
27	4,0	9	0 9,2	0,3	0,4	39	0 46,5	1,4	2,1	69	2 28,3	4,4	6,9
30	4,4	10	0 10,2	0,3	0,4	40	0 48,1	1,4	2,2	70	2 36,3	4,7	7,3
33	4,8	11	0 11,2	0,3	0,5	41	0 49,8	1,5	2,2	71	2 45,1	5,0	7,7
36	5,2	12	0 12,3	0,4	0,5	42	0 51,6	1,5	2,3	72	2 54,7	5,3	8,2
39	5,5	13	0 13,3	0,4	0,6	43	0 53,4	1,6	2,4	73	3 5,5	5,6	8,7
42	5,9	14	0 14,4	0,4	0,6	44	0 55,3	1,6	2,5	74	3 17,5	5,9	9,3
45	6,2	15	0 15,4	0,5	0,7	45	0 57,3	1,7	2,6	75	3 31,0	6,3	9,9
48	6,5	16	0 16,5	0,5	0,7	46	0 59,3	1,8	2,7	76	3 46,4	6,8	10,6
51	6,8	17	0 17,6	0,5	0,8	47	1 1,4	1,9	2,8	77	4 3,8	7,3	11,5
54	7,1	18	0 18,7	0,6	0,8	48	1 3,6	2,0	2,9	78	4 24,0	7,9	12,5
57	7,4	19	0 19,8	0,6	0,9	49	1 5,9	2,0	3,0	79	4 46,6	8,6	13,7
60	7,6	20	0 20,9	0,6	0,9	50	1 8,2	2,1	3,1	80	5 15,6	9,4	14,9
63	7,8	21	0 22,0	0,7	1,0	51	1 10,6	2,2	3,2	81	5 49,0	10,4	16,5
66	8,0	22	0 23,2	0,7	1,0	52	1 13,2	2,3	3,4	82	6 29,7	11,6	18,5
69	8,2	23	0 24,3	0,7	1,1	53	1 15,9	2,3	3,5	83	7 20,3	13,1	21,3
72	8,4	24	0 25,5	0,8	1,2	54	1 18,7	2,4	3,7	84	8 24,7	15,0	24,9
75	8,5	25	0 26,7	0,8	1,2	55	1 21,6	2,5	3,8	85	9 48,8	17,5	29,6
78	8,6	26	0 28,0	0,8	1,3	56	1 24,7	2,5	3,9	86	11 41,8		
81	8,7	27	0 29,2	0,9	1,3	57	1 28,0	2,6	4,1	87	14 18,4		
84	8,7	28	0 30,5	0,9	1,4	58	1 31,5	2,7	4,2	88	18 1,3		
87	8,8	29	0 31,8	1,0	1,4	59	1 35,2	2,8	4,3	89	23 21,4		
90	8,8	30	0 33,1	1,0	1,5	60	1 39,0	2,9	4,5	90	30 50,8	55,0	129,2

* This table also answers to the height of the barometer 29,6 inches, English measure, and to 50° of Fahrenheit's thermometer; or to the height of the barometer 30 English inches, and 55° of Fahrenheit's thermometer. And the column of variation of refraction for 10 lines of the barometer, Paris measure, answers to a difference of 9-10ths of an inch, English measure, from the given height 29,6 or 30,00 inches; and the column of variation of refraction of 10° of Reaumur's thermometer answers to a difference of 20° of Fahrenheit's thermometer from the given degree 50 or 55°.

Epochs of the mean Motion of the Moon.

Years current. Mean Time, for the Meridian of the Royal Observatory at Greenwich.

Greg. Style. Yrs. since C.	Mean Long. m				Accel. +	Mean Ano. ☽				Long. ☊			
	s	o	′	″	″	s	o	′	″	s	o	′	″
B. 1600	3	16	17	51,0	9,0	9	8	59	46	10	1	32	6
B. 20	7	29	52	34,0	5,8	10	18	44	14	9	4	41	51
B. 40	0	13	27	17,0	3,2	11	28	28	42	8	7	51	36
B. 60	4	27	2	0,0	1,4	1	8	13	10	7	11	1	21
B. 80	9	10	36	43,0	0,4	2	17	57	38	6	14	11	6
B. 1700	1	11	0	51,0	0,0	3	14	38	12	5	17	24	1
1	5	20	23	56,4	0,0	6	13	21	26	4	28	4	18
2	9	29	47	1,8	0,0	9	12	4	41	4	8	44	35
3	2	9	10	7,2	0,0	0	10	47	56	3	19	24	52
B. 4	7	1	43	47,6	0,0	3	22	35	5	3	0	1	58
5	11	11	6	53,0	0,0	6	21	18	20	2	10	42	15
6	3	20	29	58,4	0,0	9	20	1	35	1	21	22	32
7	7	29	53	3,8	0,0	0	18	44	50	1	2	2	49
B. 8	0	22	26	44,2	0,1	4	0	31	59	0	12	39	55
9	5	1	49	49,6	0,1	6	29	15	14	11	23	20	12
1710	9	11	12	55,0	0,1	9	27	58	29	11	4	0	29
11	1	20	36	0,	0,1	0	26	41	43	10	14	40	46
B. 12	6	13	9	40,8	0,1	4	8	28	52	9	25	17	52
13	10	22	32	46,2	0,2	7	7	12	7	9	5	53	9
14	3	1	55	51,6	0,2	10	5	55	22	8	16	38	26
15	7	11	18	57,0	0,2	1	4	38	37	7	27	18	43
B. 16	0	3	52	37,4	0,2	4	16	25	46	7	7	55	49
17	4	13	15	42,8	0,3	7	15	9	1	6	18	36	6
18	8	22	38	48,2	0,3	10	13	52	16	5	29	16	23
19	1	2	1	53,6	0,3	1	12	35	31	5	9	56	40
B. 1720	5	24	35	34,0	0,4	4	24	22	40	4	20	33	46
21	10	3	58	39,4	0,4	7	23	5	54	4	1	14	3
22	2	13	21	44,8	0,4	10	21	49	9	3	11	54	20
23	6	22	44	50,2	0,5	1	20	32	24	2	22	34	37
B. 24	11	15	18	30,6	0,5	5	2	19	32	2	3	11	4
25	3	24	41	36,0	0,6	8	1	2	48	1	13	52	0
26	8	4	4	41,4	0,6	10	29	46	3	0	24	32	17
27	0	13	27	46,8	0,7	1	28	29	18	0	5	12	34
B. 28	5	6	1	27,2	0,7	5	10	16	27	11	15	49	40
29	9	15	24	32,6	0,8	8	8	59	42	10	26	29	57
1730	1	24	47	38,0	0,8	11	7	42	57	10	7	10	14
31	6	4	10	43,4	0,9	2	6	26	11	9	17	50	31
B. 32	10	26	44	23,8	0,9	5	18	13	20	8	28	27	37
33	3	6	7	29,2	1,0	8	16	56	35	8	9	7	54
34	7	15	30	34,6	1,0	11	15	39	50	7	19	48	11
1735	11	24	53	40,0	1,1	2	14	23	5	7	0	28	28
B. 36	4	17	27	20,4	1,2	5	26	10	14	6	11	5	34
37	8	26	50	25,8	1,2	8	24	53	29	5	21	45	51
38	1	6	13	31 2	1,3	11	23	36	44	5	2	26	8
39	5	15	36	36,6	1,4	2	22	19	59	4	13	6	25
B. 1740	10	8	10	17,0	1,4	6	4	7	8	3	23	43	31
41	2	17	33	22,4	1,5	9	2	50	22	3	4	23	48
42	6	26	56	27,8	1,6	0	1	33	37	2	15	4	5
43	11	6	19	33,2	1,7	3	0	16	52	1	25	44	22
B. 44	3	28	53	13,6	1,7	6	12	4	1	1	6	21	28
1745	8	8	16	19,0	1,8	9	10	47	16	0	17	1	45
46	0	17	39	24,	1,9	0	9	30	31	11	27	42	2
47	4	27	2	29,8	2,0	3	8	13	46	11	8	22	19
B. 48	9	19	36	10,2	2,1	6	20	0	55	10	18	59	25
49	1	28	59	15,6	2,2	9	18	44	10	9	29	39	42
1750	6	8	22	21,0	2,2	0	17	27	25	9	10	19	59
51	10	17	45	26,4	2,3	3	16	10	39	8	21	0	16
B. 52	3	10	19	6,8	2,4	6	27	57	48	8	1	37	22
53	7	19	42	12,2	2,5	9	26	41	3	7	12	17	39
54	11	29	5	17,6	2,6	0	25	24	18	6	22	57	56
1755	4	8	28	23,0	2,7	3	24	7	33	6	3	38	13
B. 56	9	1	2	3,4	2,8	7	5	54	42	5	14	15	19
57	1	10	25	8,8	2,9	10	4	37	57	4	24	55	36
58	5	19	48	14,2	3,0	1	3	21	12	4	5	35	53
59	9	29	11	19,6	3,1	4	2	4	27	2	16	16	10

Greg. Style. Yrs. since C.	Mean Long. ☽				Accel. +	Mean Ano. ☽				Long. ☊			
	s	o	′	″	″	s	o	′	″	s	o	′	″
B. 1760	2	21	45	0,0	3,2	7	13	51	36	2	26	53	16
61	7	1	8	5,4	3,4	10	12	34	50	2	7	33	33
62	11	10	31	10,8	3,5	1	11	18	5	1	18	13	50
63	3	19	54	16,2	3,6	4	10	1	20	0	28	54	7
B. 64	8	12	27	56,6	3,7	7	21	48	29	0	9	31	13
1765	0	21	51	2,0	3,8	10	20	31	44	11	20	11	30
66	5	1	14	7,4	3,9	1	19	14	59	11	0	51	47
67	9	10	37	12,8	4,0	4	17	58	14	10	11	32	4
B. 68	2	3	10	53,2	4,2	7	29	45	28	9	22	9	10
69	6	12	33	58,6	4,3	0	28	28	38	9	2	49	27
1770	10	21	57	4,0	4,4	1	27	11	53	8	13	29	44
71	3	1	20	9,4	4,5	4	25	55	7	7	24	10	1
B. 72	7	23	53	49,8	4,7	8	7	42	16	7	4	47	7
73	0	3	16	55,2	4,8	11	6	25	31	6	15	27	24
74	4	12	40	0,6	4,9	2	5	8	46	5	26	7	41
1775	8	22	3	6,0	5,1	5	3	52	1	5	6	47	58
B. 76	1	14	36	46,4	5,2	8	15	39	10	4	17	25	4
77	5	23	59	51,8	5,3	11	14	22	25	3	28	5	21
78	10	3	22	57,2	5,5	2	13	5	40	3	8	45	38
79	2	12	46	2,6	5,6	5	11	48	55	2	19	25	55
B. 1780	7	5	19	43,0	5,8	8	23	36	4	2	0	3	1
81	11	14	42	48,4	5,9	11	22	19	18	1	10	43	18
82	3	24	5	53,8	6,1	2	21	2	33	0	21	23	35
83	8	3	28	59,2	6,2	5	19	45	48	0	2	3	52
B. 84	0	26	2	39,6	6,4	9	1	32	57	11	12	40	58
1785	5	5	25	45,0	6,5	0	0	16	12	10	23	21	15
86	9	14	48	50,4	6,7	2	28	59	27	10	4	1	32
87	1	24	11	55,8	6,8	5	27	42	42	9	14	41	49
B. 88	6	16	45	36,2	7,0	9	9	29	51	8	25	18	55
89	10	26	8	41,6	7,1	0	8	13	6	8	5	59	12
1790	3	5	31	47,0	7,3	3	6	56	21	7	16	39	29
91	7	14	54	52,4	7,5	6	5	39	35	6	27	19	46
B. 92	0	7	28	32,8	7,6	9	17	26	44	6	7	56	52
93	4	16	51	38,2	7,8	0	16	9	59	5	18	37	9
94	8	26	14	43,6	8,0	3	14	53	14	4	29	17	26
1795	1	5	37	49,0	8,1	6	13	36	29	4	9	57	43
B. 96	5	28	11	29,4	8,3	9	25	23	38	3	20	34	49
97	10	7	34	34,8	8,5	0	24	6	53	3	1	15	6
98	2	16	57	40,2	8,6	3	22	50	8	2	11	55	23
99	6	26	20	45,6	8,8	6	21	33	23	1	22	35	40
C. 1800	11	5	43	51,0	9,0	9	20	16	38	1	3	15	57
1	3	15	6	56,4	9,2	0	18	59	52	0	13	56	14
2	7	24	30	1,8	9,4	3	17	43	7	11	24	36	31
3	0	3	53	7,2	9,6	6	16	26	22	11	5	16	48
B. 4	4	26	26	47,6	9,7	9	28	13	31	10	15	53	54
1805	9	5	49	53,0	9,9	0	26	56	46	9	26	34	11
6	1	15	12	58,4	10,1	3	25	40	1	9	7	14	28
7	5	24	36	3,7	10,3	6	24	23	16	8	17	54	45
B. 8	10	17	9	44,2	10,5	10	6	10	25	7	28	31	51
9	2	26	32	49,6	10,7	1	4	53	40	7	9	12	8
1810	7	5	55	55,0	10,9	4	3	36	55	6	19	52	25
11	11	15	19	0,3	11,1	7	2	20	9	6	0	32	42
B. 12	4	7	52	40,8	11,3	10	14	7	18	5	11	9	48
13	8	17	15	46,2	11,5	1	12	50	33	4	21	50	5
14	0	26	38	51,6	11,7	4	11	33	48	4	2	30	22
1815	5	6	1	56,9	11,9	7	10	17	2	3	13	10	39
B. 16	9	28	35	37,4	12,1	10	22	4	12	2	23	47	45
17	2	7	58	42,8	12,3	1	20	47	27	2	4	28	2
18	6	17	21	48,2	12,5	4	19	30	42	1	15	8	19
19	10	26	44	53,5	12,7	7	18	13	57	0	25	48	36
B. 1820	3	19	18	34,0	13,0	11	0	1	6	0	6	25	42
B. 40	8	2	53	17,0	17,6	0	9	45	34	11	9	35	27
B. 60	0	16	28	0,0	23,0	1	19	30	2	10	12	45	12
B. 1880	5	0	2	43,0	29,2	2	29	14	30	9	15	54	57

Years current.

Epochs of the mean Motion of the Moon.
Mean Time for the Meridian of Philadelphia.

Greg. Style.	Mean Long. ☽				Accèl. +	Mean Ano. ☽				Long. ☊			
Yrs. since C.	s	o	′	″	″	s	o	′	″	s	o	′	″
1765	0	24	36	3,5	3,8	10	22	15	22	11	20	10	50
66	5	3	59	8,9	3,9	1	21	58	37	11	0	51	7
67	9	13	22	14,3	4,0	4	20	41	52	10	11	31	24
B. 68	2	5	55	54,7	4,2	8	2	29	1	9	22	8	30
69	6	14	19	0,1	4,3	11	1	12	16	9	2	48	47
1707	10	24	42	5,5	4,4	1	29	55	31	8	13	29	4
71	3	4	5	10,9	4,5	4	28	38	45	7	24	9	21
B. 72	7	26	38	51,3	4,7	8	10	25	54	7	4	46	27
73	0	6	1	56,7	4,8	11	7	9	9	6	15	26	44
74	4	15	25	2,1	4,9	2	7	52	24	5	26	7	1
1775	8	24	48	7,5	5,1	5	6	35	39	5	6	47	18
B. 76	1	17	21	47,9	5,2	8	18	22	48	4	17	24	24
77	5	26	44	53,3	5,3	11	17	6	3	3	28	4	41
78	10	6	7	58,7	5,5	2	15	49	18	3	8	44	58
79	2	15	31	4,1	5,6	5	14	32	33	2	19	25	15
B. 1780	7	8	4	44,5	5,8	8	26	19	42	2	0	2	21
81	11	17	27	49,9	5,9	11	25	2	56	1	10	42	38
82	3	26	50	55,3	6,1	2	23	46	11	0	21	22	55
83	8	6	14	0,7	6,2	5	22	29	26	0	2	3	12
B. 84	0	28	47	41,1	6,4	9	4	16	35	11	12	40	18
1785	5	8	10	46,5	6,5	0	2	59	50	10	23	20	35
86	9	17	33	51,9	6,7	3	1	43	5	10	4	0	52
87	1	26	56	57,3	6,8	6	0	26	20	9	14	41	9
B. 88	6	18	30	37,7	7,0	9	12	13	29	8	25	18	15
89	10	28	53	43,1	7,1	0	10	56	44	8	5	58	32
1790	3	8	16	48,5	7,3	3	9	39	59	7	16	38	49
91	7	17	39	53,9	7,5	6	8	23	13	6	27	19	6
B. 92	0	10	13	34,3	7,6	9	20	10	22	6	7	56	12
93	4	19	36	39,7	7,8	0	18	53	37	5	18	36	29
94	8	28	59	45,1	8,0	3	17	36	52	4	29	16	46
1795	1	8	22	50,5	8,1	6	16	20	7	4	9	57	3
B. 96	6	0	56	30,9	8,3	9	28	7	16	3	20	34	9
97	10	10	19	36,3	8,5	0	26	56	31	3	1	14	26
98	2	19	42	41,7	8,6	3	25	33	46	2	11	54	43
99	6	29	5	47,1	8,8	6	23	17	1	1	22	35	0
C. 1800	11	8	28	52,5	9,0	9	23	0	16	1	3	15	17
1	3	17	51	57,9	9,2	0	21	43	30	0	13	55	34
2	7	27	15	3,3	9,4	3	20	26	45	11	24	35	51
3	0	6	38	8,7	9,6	6	19	10	0	11	5	16	8
B. 4	4	29	11	49,1	9,7	10	0	57	9	10	15	53	14
1805	9	8	34	54,5	9,9	0	29	40	24	9	26	33	31
6	1	17	57	59,9	10,1	3	28	23	39	9	7	13	58
7	5	27	21	5,3	10,3	6	27	6	54	8	17	54	5
B. 8	10	19	54	45,7	10,5	10	8	54	3	7	28	31	11
9	2	29	17	51,1	10,7	1	7	37	18	7	9	11	2
1810	7	8	40	56,5	10,9	4	6	20	33	6	19	51	45
11	11	18	4	1,8	11,1	7	5	3	47	6	0	32	2
B. 12	4	10	37	42,3	11,3	10	16	50	56	5	11	9	8
13	8	20	0	47,7	11,5	1	15	34	11	4	21	49	25
14	0	29	23	53,1	11,7	4	14	17	26	4	2	29	52
1815	5	8	46	58,4	11,9	7	13	0	41	3	13	9	59
B. 16	10	1	20	38,9	12,1	10	24	47	50	2	23	47	5
17	2	10	43	44,3	12,3	1	23	31	5	2	4	27	22
18	6	20	6	49,7	12,5	4	22	14	20	1	15	7	39
19	10	29	29	55,0	12,7	7	20	57	35	0	25	47	56
B. 1820	3	22	3	35,5	13,0	11	2	44	44	0	6	25	2
21	8	1	26	41,9	13,2	2	1	27	59	11	17	5	19
22	0	10	49	47,3	13,4	5	0	11	14	10	27	45	56
23	4	20	12	52,7	13,6	7	28	54	29	10	8	25	53
B. 24	9	12	46	33,1	13,8	11	10	41	38	9	19	2	19
1825	1	22	9	38,5	14,1	2	9	24	53	8	29	43	36
26	6	1	32	43,9	14,3	5	8	8	8	8	10	23	53
27	10	10	55	49,3	14,5	8	6	51	22	7	21	3	50

Greg. Style.	Mean Long. ☽				Accel. +	Mean Ano. ☽				Long. ☊			
Yrs. since C.	s	o	′	″	″	s	o	′	″	s	o	′	″
B. 1828	3	3	29	29,7	14,7	11	18	38	31	7	1	40	56
29	7	12	52	35,1	14,9	2	17	21	46	6	12	21	13
30	11	22	15	40,5	15,2	5	16	5	1	5	23	1	30
31	4	1	38	45,9	15,4	8	14	48	16	5	3	41	47
B. 32	8	24	12	26,3	15,6	11	26	35	25	4	14	18	53
33	1	3	35	31,7	15,8	2	25	18	40	3	24	59	10
34	5	12	58	36,1	16,1	5	24	1	54	3	5	39	27

Mean motion of the Moon in Years.

Ju. Years.	Long. ☽					Mean Anom. ☽					Motion ☊ ☽ Retro.				
	s	o	′	″	‴	s	o	′	″	‴	s	o	′	″	‴
1	4	9	23	5	23,5	2	28	43	14	54,5	0	19	19	43	5,5
2	8	18	46	10	47,0	5	27	26	29	49,0	1	8	39	26	11,0
3	0	28	9	16	10,5	8	26	9	44	43,5	1	27	59	9	16,5
B. 4	5	20	42	56	36,0	0	7	56	53	36,0	2	17	22	3	0,5
5	10	0	6	1	59,5	3	6	40	8	30,5	3	6	41	46	6,0
6	2	9	29	7	23,0	6	5	23	23	25,0	3	26	1	29	11,5
7	6	18	52	12	45,5	9	4	6	38	19,5	4	15	21	12	17,0
B. 8	11	11	25	53	12,0	0	15	53	47	12,0	5	4	44	6	1,0
9	3	20	48	58	35,5	3	14	37	2	6,5	5	24	3	49	6,5
10	8	0	12	3	59,0	6	13	20	17	1,0	6	13	23	32	12,0
B. 20	4	13	34	43	8,0	1	9	44	28	0,0	0	26	50	15	0,0
B. 40	8	27	9	26	0,0	2	19	28	56	0,0	1	23	40	30	0,0
B. 60	1	10	44	9	0,0	3	29	13	24	0,0	2	20	30	45	0,0
B. 80	5	24	18	52	0,0	5	8	57	52	0,0	3	17	21	0	0,0
B. 100	10	7	53	35	0,0	6	18	42	20	0,0	4	14	11	15	0,0

Moon's mean motion for Months and Days.

JANUARY.

Days.	Mean motion ☽				Mean motion Ano.				Mean Mo. ☊		
	s	o	′	″	s	o	′	″	o	′	″
1	0	13	10	35,0	0	13	3	54,0	0	3	10,6
2	0	26	21	10,1	0	26	7	47,9	0	6	21,3
3	1	9	31	45,1	1	9	11	41,9	0	9	31,9
4	1	22	42	20,1	1	22	15	35,8	0	12	42,6
5	2	5	52	55,1	2	5	19	29,8	0	15	53,2
6	2	19	3	30,2	2	18	23	23,8	0	19	3,8
7	3	2	14	5,2	3	1	27	17,7	0	22	14,5
8	3	15	24	40,2	3	14	31	11,7	0	25	25,1
9	3	28	35	15,3	3	27	35	5,6	0	28	35,8
10	4	11	45	50,3	4	10	38	59,6	0	31	46,4
11	4	24	56	25,3	4	23	42	53,5	0	34	57,0
12	5	8	7	0,3	5	6	46	47,5	0	38	7,7
13	5	21	17	35,4	5	19	50	41,5	0	41	18,3
14	6	4	28	10,4	6	2	54	35,4	0	44	29,0
15	6	17	38	45,4	6	15	58	29,4	0	47	39,6
16	7	0	49	20,5	6	29	2	23,3	0	50	50,2
17	7	13	59	55,5	7	12	6	17,3	0	54	0,9
18	7	27	10	30,5	7	25	10	11,3	0	57	11,5
19	8	10	21	5,5	8	8	14	5,2	1	0	22,1
20	8	23	31	40,6	8	21	17	59,2	1	3	32,8
21	9	6	42	15,6	9	4	21	53,1	1	6	43,4
22	9	19	52	50,6	9	17	25	47,1	1	9	54,5
23	10	3	3	25,7	10	0	29	41,1	1	13	4,7
24	10	16	14	0,7	10	13	33	35,0	1	16	15,3
25	10	29	24	35,7	10	26	37	29,0	1	19	26,0
26	11	12	35	10,7	11	9	41	22,9	1	22	36,6
27	11	25	45	45,8	11	22	45	16,9	1	25	47,3
28	0	8	56	20,8	0	5	49	10,8	1	28	57,9
29	0	22	6	55,8	0	18	53	4,8	1	32	8,5
30	1	5	17	30,9	1	1	56	58,8	1	35	19,2
31	1	18	28	5,9	1	15	0	52,7	1	38	29,8

MOON's mean Motion for Months and Days.

FEBRUARY.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Me. Mo. ☊ o	′	″
1	2	1	38	40,9	1	28	4	46,7	1	41	40,4
2	2	14	49	15,9	2	11	8	40,6	1	44	51,1
3	2	27	59	51,0	2	24	12	34,6	1	48	1,7
4	3	11	10	26,0	3	7	16	28,6	1	51	12,4
5	3	24	21	1,0	3	20	20	22,5	1	54	23,0
6	4	7	31	36,1	4	3	24	16,5	1	57	33,6
7	4	20	42	11,1	4	16	28	10,4	2	0	44,3
8	5	3	52	46,1	4	29	32	4,4	2	3	54,9
9	5	17	3	21,1	5	12	35	58,3	2	7	5,5
10	6	0	13	56,2	5	25	39	52,3	2	10	16,2
11	6	13	24	31,2	6	8	43	46,3	2	13	26,8
12	6	26	35	6,2	6	21	47	40,2	2	16	37,5
13	7	9	45	41,3	7	4	51	34,2	2	19	48,1
14	7	22	56	16,3	7	17	55	28,1	2	22	58,7
15	8	6	6	51,3	8	0	59	22,1	2	26	9,4
16	8	19	17	26,3	8	14	3	16,1	2	29	20,0
17	9	2	28	1,4	8	27	7	10,0	2	32	30,7
18	9	15	38	36,4	9	10	11	4,0	2	35	41,3
19	9	28	49	11,4	9	23	14	57,9	2	38	51,9
20	10	11	59	46,5	10	6	18	51,9	2	42	2,6
21	10	25	10	21,5	10	19	22	45,9	2	45	13,2
22	11	8	20	56,5	11	2	26	39,8	2	48	23,8
23	11	21	31	31,5	11	15	30	33,8	2	51	34,5
24	0	4	42	6,6	11	28	34	27,7	2	54	45,1
25	0	17	52	41,6	0	11	38	21,7	2	57	55,8
26	1	1	3	16,6	0	24	42	15,6	3	1	6,4
27	1	14	13	51,7	1	7	46	9,6	3	4	17,0
28	1	27	24	26,7	1	20	50	3,6	3	7	27,7

*** In the Months January and February of a Biſſextile Year, ſubtract 1 from the Number of Days given.

MARCH.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Me. Mo. ☊ o	′	″
1	2	10	35	1,7	2	3	53	57,5	3	10	38,3
2	2	23	45	36,7	2	16	57	51,5	3	13	49,0
3	3	6	56	11,8	3	0	1	45,4	3	16	59,6
4	3	20	6	46,8	3	13	5	39,4	3	20	10,2
5	4	3	17	21,8	3	26	9	33,4	3	23	20,9
6	4	16	27	56,9	4	9	13	27,3	3	26	31,5
7	4	29	38	31,9	4	22	17	21,3	3	29	42,1
8	5	12	49	6,9	5	5	21	15,2	3	32	52,8
9	5	25	59	41,9	5	18	25	9,2	3	36	3,4
10	6	9	10	17,0	6	1	29	3,1	3	39	14,1
11	6	22	20	52,0	6	14	32	57,1	3	42	24,7
12	7	5	31	27,0	6	27	36	51,1	3	45	35,3
13	7	18	42	2,1	7	10	40	45,0	3	48	46,0
14	8	1	52	37,1	7	23	44	39,0	3	51	56,6
15	8	15	3	12,1	8	6	48	32,9	3	55	7,3
16	8	28	13	47,1	8	19	52	26,9	3	58	17,9
17	9	11	24	22,2	9	2	56	20,9	4	1	28,5
18	9	24	34	57,2	9	16	0	14,8	4	4	39,2
19	10	7	45	32,2	9	29	4	8,8	4	7	49,8
20	10	20	56	7,3	10	12	8	2,7	4	11	0,4
21	11	4	6	42,3	10	25	11	56,7	4	14	11,1
22	11	17	17	17,3	11	8	15	50,7	4	17	21,7
23	0	0	27	52,3	11	21	19	44,6	4	20	32,4
24	0	13	38	27,4	0	4	23	38,6	4	23	43,0
25	0	26	49	2,4	0	17	27	32,5	4	26	53,6
26	1	9	59	37,4	1	0	31	26,5	4	30	4,3
27	1	23	10	12,5	1	13	35	20,4	4	33	14,9
28	2	6	20	47,5	1	26	39	14,4	4	36	25,5
29	2	19	31	22,5	2	9	43	8,4	4	39	36,2
30	3	2	41	57,5	2	22	47	2,3	4	42	46,8
31	3	15	52	32,6	3	5	50	56,2	4	45	57,5

APRIL.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Me. mo. ☊ o	′	″
1	3	29	3	7,6	3	18	54	50,2	4	49	8,1
2	4	12	13	42,6	4	1	58	44,2	4	52	18,7
3	4	25	24	17,7	4	15	2	38,2	4	55	29,4
4	5	8	34	52,7	4	28	6	32,1	4	58	40,0
5	5	21	45	27,7	5	11	10	26,1	5	1	50,7
6	6	4	56	2,7	5	24	14	20,0	5	5	1,3
7	6	18	6	37,8	6	7	18	14,0	5	8	11,9
8	7	1	17	12,8	6	20	22	7,9	5	11	22,6
9	7	14	27	47,8	7	3	26	1,9	5	14	33,2
10	7	27	38	22,9	7	16	29	55,9	5	17	43,9
11	8	10	48	57,9	7	29	33	49,8	5	20	54,5
12	8	23	59	32,9	8	12	37	43,8	5	24	5,1
13	9	7	10	7,9	8	25	41	37,7	5	27	15,8
14	9	20	20	43,0	9	8	45	31,7	5	30	26,4
15	10	3	31	18,0	9	21	49	25,7	5	33	37,1
16	10	16	41	53,0	10	4	53	19,6	5	36	47,7
17	10	29	52	28,0	10	17	57	13,6	5	39	58,3
18	11	13	3	3,1	11	1	1	7,5	5	43	9,0
19	11	26	13	38,1	11	14	5	1,5	5	46	19,6
20	0	9	24	13,1	11	27	8	55,5	5	49	30,3
21	0	22	34	48,2	0	10	12	49,4	5	52	40,9
22	1	5	45	23,2	0	23	16	43,4	5	55	51,5
23	1	18	55	58,2	1	6	20	37,3	5	59	2,2
24	2	2	6	33,2	1	19	24	31,3	6	2	12,8
25	2	15	17	8,3	2	2	28	25,2	6	5	23,4
26	2	28	27	43,3	2	15	32	19,2	6	8	34,1
27	3	11	38	18,3	2	28	36	13,2	6	11	44,7
28	3	24	48	53,4	3	11	40	7,1	6	14	55,4
29	4	7	59	28,4	3	24	44	1,1	6	18	6,0
30	4	21	10	3,4	4	7	47	55,0	6	21	16,6

MAY.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mo. Me. ☊ o	′	″
1	5	4	20	38,4	4	20	51	49,0	6	24	27,3
2	5	17	31	13,5	5	3	55	43,0	6	27	37,9
3	6	0	41	48,5	5	16	59	36,9	6	30	48,5
4	6	13	52	23,5	6	0	3	30,9	6	33	59,2
5	6	27	2	58,6	6	13	7	24,8	6	37	9,8
6	7	10	13	33,6	6	26	11	18,8	6	40	20,5
7	7	23	24	8,6	7	9	15	12,8	6	43	31,1
8	8	6	34	43,6	7	22	19	6,7	6	46	41,7
9	8	19	45	18,7	8	5	23	0,7	6	49	52,4
10	9	2	55	53,7	8	18	26	54,6	6	53	3,0
11	9	16	6	28,7	9	1	30	48,6	6	56	13,7
12	9	29	17	3,8	9	14	34	42,5	6	59	24,3
13	10	12	27	38,8	9	27	38	36,5	7	2	34,9
14	10	25	38	13,8	10	10	42	30,5	7	5	45,6
15	11	8	48	48,8	10	23	46	24,4	7	8	56,2
16	11	21	59	23,9	11	6	50	18,4	7	12	6,8
17	0	5	9	58,9	11	19	54	12,3	7	15	17,5
18	0	18	20	33,9	0	2	58	6,3	7	18	28,1
19	1	1	31	9,0	0	16	2	0,2	7	21	38,8
20	1	14	41	44,0	0	29	5	54,2	7	24	49,4
21	1	27	52	19,0	1	12	9	48,2	7	28	0,0
22	2	11	2	54,0	1	25	13	42,1	7	31	10,7
23	2	24	13	29,1	2	8	17	36,1	7	34	21,3
24	3	7	24	4,1	2	21	21	30,0	7	37	32,0
25	3	20	34	39,1	3	4	25	24,0	7	40	42,6
26	4	3	45	14,2	3	17	29	17,9	7	43	53,2
27	4	16	55	49,2	4	0	33	11,9	7	47	3,9
28	5	0	6	24,2	4	13	37	5,9	7	50	14,5
29	5	13	16	59,2	4	26	40	59,8	7	53	25,1
30	5	26	27	34,3	5	9	44	53,8	7	56	35,8
31	6	9	38	9,3	5	22	48	47,7	7	59	46,4

MOON's Mean Motion for Months and Days.

JUNE.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. mo. ☊ o	′	″
1	6	22	48	44,3	6	5	52	41,7	8	2	57,1
2	7	5	59	19,4	6	18	56	35,7	8	6	7,7
3	7	19	9	54,4	7	2	0	29,6	8	9	18,3
4	8	2	20	29,4	7	15	4	23,6	8	12	29,0
5	8	15	31	4,4	7	28	8	17,5	8	15	39,6
6	8	28	41	39,5	8	11	12	11,5	8	18	50,2
7	9	11	52	14,5	8	24	16	5,4	8	22	0,9
8	9	25	2	49,5	9	7	19	59,4	8	25	11,5
9	10	8	13	24,6	9	20	23	53,4	8	28	22,2
10	10	21	23	59,6	10	3	27	47,3	8	31	32,8
11	11	4	34	34,6	10	16	31	41,3	8	34	43,4
12	11	17	45	9,6	10	29	35	35,2	8	37	54,1
13	0	0	55	44,7	11	12	39	29,2	8	41	4,7
14	0	14	6	19,7	11	25	43	23,2	8	44	15,4
15	0	27	16	54,7	0	8	47	17,1	8	47	26,0
16	1	10	27	29,8	0	21	51	11,1	8	50	36,6
17	1	23	38	4,8	1	4	55	5,0	8	53	47,3
18	2	6	48	39,8	1	17	58	59,0	8	56	57,9
19	2	19	59	14,8	2	1	2	53,0	9	0	8,5
20	3	3	9	49,9	2	14	6	46,9	9	3	19,2
21	3	16	20	24,9	2	27	10	40,9	9	6	29,8
22	3	29	30	59,9	3	10	14	34,8	9	9	40,5
23	4	12	41	35,0	3	23	18	28,8	9	12	51,1
24	4	25	52	10,0	4	6	22	22,7	9	16	1,7
25	5	9	2	45,0	4	19	26	16,7	9	19	12,4
26	5	22	13	20,0	5	2	30	10,7	9	22	23,0
27	6	5	23	55,1	5	15	34	4,6	9	25	33,7
28	6	18	34	30,1	5	28	37	58,6	9	28	44,3
29	7	1	45	5,1	6	11	41	52,5	9	31	54,9
30	7	14	55	40,2	6	24	45	46,5	9	35	5,6

JULY.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. Mo. ☊ o	′	″
1	7	28	6	15,2	7	7	49	40,5	9	38	16,2
2	8	11	16	50,2	7	20	53	34,4	9	41	26,9
3	8	24	27	25,2	8	3	57	28,4	9	44	37,5
4	9	7	38	0,3	8	17	1	22,3	9	47	48,1
5	9	20	48	35,3	9	0	5	16,3	9	50	58,8
6	10	3	59	10,3	9	13	9	10,3	9	54	9,4
7	10	17	9	45,4	9	26	13	4,2	9	57	20,0
8	11	0	20	20,4	10	9	16	58,2	10	0	30,7
9	11	13	30	55,4	10	22	20	52,1	10	3	41,3
10	11	26	41	30,4	11	5	24	46,1	10	6	52,0
11	0	9	52	5,5	11	18	28	40,0	10	10	2,6
12	0	23	2	40,5	0	1	32	34,0	10	13	13,2
13	1	6	13	15,5	0	14	36	28,0	10	16	23,9
14	1	19	23	50,6	0	27	40	21,0	10	19	34,5
15	2	2	34	25,6	1	10	44	15,9	10	22	45,2
16	2	15	45	0,6	1	23	48	9,8	10	25	55,8
17	2	28	55	35,6	2	6	52	3,8	10	29	6,4
18	3	12	6	10,7	2	19	55	57.8	10	32	17,1
19	3	25	16	45,7	3	2	59	51,7	10	35	27,7
20	4	8	27	20,7	3	16	3	45,7	10	38	38,4
21	4	21	37	55,8	3	29	7	39,6	10	41	49,0
22	5	4	48	30,8	4	12	11	33,6	10	44	59,6
23	5	17	59	5,8	4	25	15	27,5	10	48	10,3
24	6	1	9	40,8	5	8	19	21,5	10	51	20,9
25	6	14	20	15,9	5	21	23	15,5	10	54	31,6
26	6	27	30	50,9	6	4	27	9,4	10	57	42,2
27	7	10	41	25,9	6	17	31	3,4	11	0	52,8
28	7	23	52	1,0	7	0	34	57,3	11	4	3,5
29	8	7	2	36,0	7	13	38	51,3	11	7	14,1
30	8	20	13	11,0	7	26	42	45,3	11	10	24,7
31	9	3	23	46,0	8	9	46	39,2	11	13	35,4

AUGUST.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. mo. ☊ o	′	″
1	9	16	34	21,1	8	22	50	33,2	11	16	46,0
2	9	29	44	56,1	9	5	54	27,1	11	19	56,7
3	10	12	55	31,1	9	18	58	21,1	11	23	7,3
4	10	26	6	6,2	10	2	2	15,1	11	26	17,9
5	11	9	16	41,2	10	15	6	9,0	11	29	28,6
6	11	22	27	16,2	10	28	10	3,0	11	32	39,2
7	0	5	37	51,2	11	11	13	56,9	11	35	49,9
8	0	18	48	26,3	11	24	17	50,9	11	39	0,5
9	1	1	59	1,3	0	7	21	44,8	11	42	11,1
10	1	15	9	36,3	0	20	25	38,8	11	45	21,8
11	1	28	20	11,4	1	3	29	32,8	11	48	32,4
12	2	11	30	46,4	1	16	33	26,7	11	51	43,1
13	2	24	41	21,4	1	29	37	20,7	11	54	53,7
14	3	7	51	56,4	2	12	41	14,6	11	58	4,3
15	3	21	2	31,5	2	25	45	8,6	12	1	15,0
16	4	4	13	6,5	3	8	49	2,6	12	4	25,6
17	4	17	23	41,5	3	21	52	56,5	12	7	36,2
18	5	0	34	16,6	4	4	56	50,5	12	10	46,9
19	5	13	44	51,6	4	18	0	44,4	12	13	57,5
20	5	26	55	26,6	5	1	4	38,4	12	17	8,2
21	6	10	6	1,6	5	14	8	32,3	12	20	18,8
22	6	23	16	36,7	5	27	12	26,3	12	23	29,4
23	7	6	27	11,7	6	10	16	20,3	12	26	40,1
24	7	19	37	46,7	6	23	20	14,2	12	29	50,7
25	8	2	48	21,8	7	6	24	8,2	12	33	1,4
26	8	15	58	56,8	7	19	28	2,1	12	36	12,0
27	8	29	9	31,8	8	2	31	56,1	12	39	22,6
28	9	12	20	6,8	8	15	35	50,1	12	42	33,3
29	9	25	30	41,9	8	28	39	44,0	12	45	43,9
30	10	8	41	16,9	9	11	43	38,0	12	48	54,5
31	10	21	51	51,9	9	24	47	31.9	12	52	5,2

SEPTEMBER.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. mo. ☊ o	′	″
1	11	5	2	27,0	10	7	51	25,9	12	55	15,8
2	11	18	13	2,0	10	20	55	19,9	12	58	26,5
3	0	1	23	37,0	11	3	59	13,8	13	1	37,1
4	0	14	34	12,0	11	17	3	7,8	13	4	47,7
5	0	27	44	47,1	0	0	7	1,7	13	7	58,4
6	1	10	55	22,1	0	13	10	55,7	13	11	9,0
7	1	24	5	57,1	0	26	14	49,6	13	14	19,7
8	2	7	16	32,2	1	9	18	43,6	13	17	30,3
9	2	20	27	7,2	1	22	22	37,6	13	20	40,9
10	3	3	37	42,2	2	5	26	31,5	13	23	51,6
11	3	16	48	17,2	2	18	30	25,5	13	27	2,2
12	3	29	58	52,3	3	1	34	19,4	13	30	12,9
13	4	13	9	27,3	3	14	38	13,4	13	33	23,5
14	4	26	20	2,3	3	27	42	7,4	13	36	34,1
15	5	9	30	37,4	4	10	46	1,3	13	39	44,8
16	5	22	41	12,4	4	23	49	55,3	13	42	55,4
17	6	5	51	47,4	5	6	53	49,2	13	46	6,0
18	6	19	2	22,4	5	19	57	43,2	13	49	16,7
19	7	2	12	57,5	6	3	1	37,2	13	52	27,3
20	7	15	23	32,5	6	16	5	31,1	13	55	38,0
21	7	28	34	7,5	6	29	9	25,1	13	58	48,6
22	8	11	44	42,6	7	12	13	19,0	14	1	59,2
23	8	24	55	17,6	7	25	17	13,0	14	5	9,9
24	9	8	5	52,6	8	8	21	6,9	14	8	20,5
25	9	21	16	27,6	8	21	25	0,9	14	11	31,1
26	10	4	27	2,7	9	4	28	54,9	14	14	41,8
27	10	17	37	37,7	9	17	32	48,8	14	17	52,4
28	11	0	48	12,7	10	0	36	42,8	14	21	3,1
29	11	13	58	47,8	10	13	40	36,7	14	24	13,7
30	11	27	9	22,8	10	26	44	30,7	14	27	24,3

MOON's Mean Motion for Months, Days and Hours.

October.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. mo. ☊ o	′	″
1	0	10	19	57,8	11	9	48	24,7	14	30	35,0
2	0	23	30	32,8	11	22	52	18,6	14	33	45,6
3	1	6	41	7,9	0	5	56	12,6	14	36	56,3
4	1	19	51	42,9	0	19	0	6,5	14	40	6,9
5	2	3	2	17,9	1	2	4	0,5	14	43	17,5
6	2	16	12	53,0	1	15	7	54,4	14	46	28,2
7	2	29	23	28,0	1	28	11	48,4	14	49	38,8
8	3	12	34	3,0	2	11	15	42,4	14	52	49,4
9	3	25	44	38,0	2	24	19	36,3	14	56	0,1
10	4	8	55	13,1	3	7	23	30,3	14	59	10,7
11	4	22	5	48,1	3	20	27	24,2	15	2	21,4
12	5	5	16	23,1	4	3	31	18,2	15	5	32,0
13	5	18	26	58,1	4	16	35	12,2	15	8	42,6
14	6	1	37	33,2	4	29	39	6,1	15	11	53,3
15	6	14	48	8,2	5	12	43	0,1	15	15	3,9
16	6	27	58	43,2	5	25	46	54,0	15	18	14,6
17	7	11	9	18,3	6	8	50	48,0	15	21	25,2
18	7	24	19	53,3	6	21	54	42,0	15	24	35,8
19	8	7	30	28,3	7	4	58	35,9	15	27	46,5
20	8	20	41	3,3	7	18	2	29,9	15	30	57,1
21	9	3	51	38,4	8	1	6	23,8	15	34	7,8
22	9	17	2	13,4	8	14	10	17,8	15	37	18,4
23	10	0	12	48,4	8	27	14	11,7	15	40	29,0
24	10	13	23	23,5	9	10	18	5,7	15	43	39,7
25	10	26	33	58,5	9	23	21	59,7	15	46	50,3
26	11	9	44	33,5	10	6	25	53,6	15	50	0,9
27	11	22	55	8,5	10	19	29	47,6	15	53	11,6
28	0	6	5	43,6	11	2	33	41,5	15	56	22,2
29	0	19	16	18,6	11	15	37	35,5	15	59	32,9
30	1	2	26	53,6	11	28	41	29.5	16	2	43,5
31	1	15	37	28,7	0	11	45	23,4	16	5	54,1

November.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. Mo. ☊ o	′	″
1	1	28	48	3,7	0	24	49	17,4	16	9	4,8
2	2	11	58	38,7	1	7	53	11,3	16	12	15,4
3	2	25	9	13,7	1	20	57	5,3	16	15	26,1
4	3	8	19	48,8	2	4	0	59,2	16	18	36,7
5	3	21	30	23,8	2	17	4	53,2	16	21	47,3
6	4	4	40	58,8	3	0	8	47,2	16	24	58,0
7	4	17	51	33,9	3	13	12	41,1	16	28	8,6
8	5	1	2	8,9	3	26	16	35,1	16	31	19,3
9	5	14	12	43,9	4	9	20	29,0	16	34	29,9
10	5	27	23	18,9	4	22	24	23,0	16	37	40,5
11	6	10	33	54,0	5	5	28	17,0	16	40	51,2
12	6	23	44	29,0	5	18	32	10,9	16	44	1,8
13	7	6	55	4,0	6	1	36	4,9	16	47	12,4
14	7	20	5	39,1	6	14	39	58,8	16	50	23,1
15	8	3	16	14,1	6	27	43	52,8	16	53	33,7
16	8	16	26	49,1	7	10	47	46,8	16	56	44,4
17	8	29	37	24,1	7	23	51	40,7	16	59	55,0
18	9	12	47	59,2	8	6	55	34,7	17	3	5,6
19	9	25	58	34,2	8	19	59	28,6	17	6	16,3
20	10	9	9	9,2	9	3	3	22,6	17	9	26,9
21	10	22	19	44,3	9	16	7	16,5	17	12	37,6
22	11	5	30	19,3	9	29	11	10,5	17	15	48,2
23	11	18	40	54,3	10	12	15	4,5	17	18	58,8
24	0	1	51	29,3	10	25	18	58,4	17	22	9,5
25	0	15	2	4,4	11	8	22	52,4	17	25	20,1
26	0	28	12	39,4	11	21	26	46,3	17	28	30,7
27	1	11	23	14,4	0	4	30	40,3	17	31	41,4
28	1	24	33	49,5	0	17	34	34,3	17	34	52,0
29	2	7	44	24,5	1	0	38	28,2	17	38	2,7
30	2	20	54	59,5	1	13	42	22,2	17	41	13,3

December.

Days.	Mean motion ☽ s	o	′	″	Mo. mean Ano. s	o	′	″	Mea. mo. ☊ o	′	″
1	3	4	5	34,5	1	26	46	16,1	17	44	23,9
2	3	17	16	9,6	2	9	50	10,1	17	47	34,6
3	4	0	26	44,6	2	22	54	4,1	17	50	45,2
4	4	13	37	19,6	3	5	57	58,0	17	53	55,9
5	4	26	47	54,7	3	19	1	52,0	17	57	6,5
6	5	9	58	29,7	4	2	5	45,9	18	0	17,1
7	5	23	9	4,7	4	15	9	39,9	18	3	27,8
8	6	6	19	39,7	4	28	13	33,8	18	6	38,4
9	6	19	30	14,8	5	11	17	27,8	18	9	49,1
10	7	2	40	49,8	5	24	21	21,8	18	12	59,7
11	7	15	51	24,8	6	7	25	15,7	18	16	10,3
12	7	29	1	59,9	6	20	29	9,7	18	19	21,0
13	8	12	12	34,9	7	3	33	3,6	18	22	31,6
14	8	25	23	9,9	7	16	36	57,6	18	25	42,2
15	9	8	33	44,9	7	29	40	51,5	18	28	52,9
16	9	21	44	20,0	8	12	44	45,5	18	32	3,5
17	10	4	54	55,0	8	25	48	39,5	18	35	14,2
18	10	18	5	30,0	9	8	52	33,4	18	38	24,8
19	11	1	16	5,1	9	21	56	27,4	18	41	35,4
20	11	14	26	40,1	10	5	0	21,3	18	44	46,1
21	11	27	37	15,1	10	18	4	15,3	18	47	56,7
22	0	10	47	50,1	11	1	8	9,3	18	51	7,4
23	0	23	58	25,2	11	14	12	3,2	18	54	18 0
24	1	7	9	0,2	11	27	15	57,2	18	57	28 6
25	1	20	19	35,2	0	10	19	51,1	19	0	39 3
26	2	3	30	10,3	0	23	23	45,1	19	3	49 9
27	2	16	40	45,3	1	6	27	39,1	19	7	0 5
28	2	29	51	20,3	1	19	31	33,0	19	10	11, 2
29	3	13	1	55,3	2	2	35	27,0	19	13	21, 8
30	3	26	12	30,4	2	15	39	20,9	19	16	32, 5
31	4	9	23	5,4	2	28	43	14,9	19	19	43, 1

For Hours.

Hrs.	Longitude ☽ o	′	″	Anomaly. o	′	″	☊ ′	″
1	☻ 32	56,5		0 32	39,7		0	7,9
2	1 5	52,9		1 5	19,5		0	15,9
3	1 38	49,4		1 37	59,2		0	23,8
4	2 11	45,8		2 10	39,0		0	31,8
5	2 44	42,3		2 43	18,7		0	39,7
6	3 17	38,8		3 15	58,5		0	47,7
7	3 50	35,2		3 48	38,2		0	55,6
8	4 23	31,7		4 21	18,0		1	3,6
9	4 56	28,1		4 53	57,7		1	11,5
10	5 29	24,6		5 26	37,5		1	19,4
11	6 2	21,1		5 59	17,2		1	27,4
12	6 35	17,5		6 31	57,0		1	35,3
13	7 8	14,0		7 4	36,7		1	43,3
14	7 41	10,4		7 37	16,5		1	51,2
15	8 14	6,9		8 9	56,2		1	59,2
16	8 47	3,4		8 42	36,0		2	7,1
17	9 19	59,8		9 15	15,7		2	15,0
18	9 52	56,3		9 47	55,5		2	23,0
19	10 25	52,7		10 20	35,2		2	30,9
20	10 58	49,2		10 53	15,0		2	38,9
21	11 31	45,6		11 25	54,7		2	46,8
22	12 4	42,1		11 58	34,5		2	54,8
23	12 37	38,6		12 31	14,2		3	2,7
24	13 10	35,0		13 3	54,0		3	10,6
25	13 43	31,5		13 36	33,7		3	18,6
26	14 16	27,9		14 9	13,5		3	26,5
27	14 49	24,4		14 41	53,2		3	34,5
28	15 22	20,9		15 14	33,0		3	42,4
29	15 55	17,3		15 47	12,7		3	50,4
30	16 28	13,8		16 19	52,4		3	58,3

Moon's mean motion for Minutes & Seconds.

	Lon. ☽		Anom.		☊
′	′	″	′	″	″
″	″	‴	″	‴	‴
1	0	32,9	0	32,7	0,1
2	1	5,9	1	5,3	0,3
3	1	38,8	1	38,0	0,4
4	2	11,8	2	10,6	0,5
5	2	44,7	2	43,3	0,7
6	3	17,6	3	16,0	0,8
7	3	50,6	3	48,6	0,9
8	4	23,5	4	21,3	1,1
9	4	56,5	4	54,0	1,2
10	5	29,4	5	26,6	1,3
11	6	2,4	5	59,3	1,5
12	6	35,3	6	31,9	1,6
13	7	8,2	7	4,6	1,7
14	7	41,2	7	37,3	1,9
15	8	14,1	8	9,9	2,0
16	8	47,1	8	42,6	2,1
17	9	20,0	9	15,3	2,3
18	9	52,9	9	47,9	2,4
19	10	25,9	10	20,6	2,5
20	10	58,8	10	53,2	2,6
21	11	31,8	11	25,9	2,8
22	12	4,7	11	58,6	2,9
23	12	37,6	12	31,2	3,0
24	13	10,6	13	3,9	3,2
25	13	43,5	13	36,6	3,3
26	14	16,5	14	9,2	3,4
27	14	49,4	14	41,9	3,6
28	15	22,3	15	14,5	3,7
29	15	55,3	15	47,2	3,8
30	16	28,2	16	19,9	4,0
31	17	1,2	16	52,5	4,1
32	17	34,1	17	25,2	4,2
33	18	7,1	17	57,9	4,4
34	18	40,0	18	30,5	4,5
35	19	12,9	19	3,2	4,6
36	19	45,9	19	35,8	4,8
37	20	18,8	20	8,5	4,9
38	20	51,8	20	41,2	5,0
39	21	24,7	21	13,8	5,2
40	21	57,6	21	46,5	5,3
41	22	30,6	22	19,2	5,4
42	23	3,5	22	51,8	5,6
43	23	36,5	23	24,5	5,7
44	24	9,4	23	57,1	5,8
45	24	42,3	24	29,8	6,0
46	25	15,3	25	2,5	6,1
47	25	48,2	25	35,1	6,2
48	26	21,2	26	7,8	6,4
49	26	54,1	26	40,5	6,5
50	27	27,0	27	13,1	6,6
51	28	0,0	27	45,8	6,8
52	28	32,9	28	18,5	6,9
53	29	5,9	28	51,1	7,0
54	29	38,8	29	23,8	7,1
55	30	11,8	29	56,4	7,3
56	30	44,7	30	29,1	7,4
57	31	17,6	31	1,8	7,5
58	31	50,6	31	34,4	7,7
59	32	23,5	32	7,1	7,9
60	32	56,5	32	39,8	7,9

Annual Equation of MOON's Node.

Argument. Sun's Mean Anomaly.

S	0			1			2			S
	+		Diff.	+		Diff.	+		Diff.	
0	′	″	″	′	″	″	′	″	″	0
0	0	0		4	30		7	52		30
1	0	9	9	4	38	8	7	57	5	29
2	0	19	10	4	46	8	8	1	4	28
3	0	28	9	4	54	8	8	6	5	27
4	0	38	10	5	2	8	8	11	5	26
5	0	47	9	5	10	8	8	15	4	25
6	0	56	9	5	18	8	8	19	4	24
7	1	6	10	5	26	8	8	23	4	23
8	1	15	9	5	33	7	8	27	4	22
9	1	24	9	5	41	7	8	31	4	21
10	1	34	10	5	48	7	8	34	3	20
11	1	43	9	5	55	7	8	37	3	19
12	1	52	9	6	2	7	8	41	4	18
13	2	1	9	6	10	7	8	44	3	17
14	2	10	9	6	17	6	8	47	3	16
15	2	19	9	6	23	7	8	49	2	15
16	2	28	9	6	30	7	8	52	3	14
17	2	38	10	6	37	6	8	55	3	13
18	2	47	9	6	43	7	8	57	2	12
19	2	56	9	6	50	6	8	59	2	11
20	3	4	8	6	56	6	9	1	2	10
21	3	13	9	7	2	6	9	3	1	9
22	3	22	9	7	8	6	9	4	2	8
23	3	31	9	7	14	6	9	6	1	7
24	3	39	8	7	20	6	9	7	1	6
25	3	48	9	7	26	6	9	8	1	5
26	3	57	9	7	31	5	9	9	1	4
27	4	5	8	7	37	6	9	10	1	3
28	4	13	8	7	42	5	9	11	1	2
29	4	22	9	7	47	5	9	11	0	1
30	4	30	8	7	52	5	9	12	1	0
S	11			10			9			S

Annual Equation of Moon's Mean Node.

Argument. Sun's Mean Anomaly.

S	3			4			5			S
	+		Diff.	+		Diff.	+		Diff.	
0	′	″	″	′	″	″	′	″	″	0
0	9	12		8	4		4	42		30
1	9	12	0	7	59	5	4	33	9	29
2	9	12	0	7	54	5	4	25	8	28
3	9	12	0	7	49	5	4	16	9	27
4	9	11	1	7	44	5	4	7	9	26
5	9	11	0	7	38	6	3	58	9	25
6	9	10	1	7	33	5	3	49	9	24
7	9	9	1	7	27	6	3	40	9	23
8	9	8	1	7	21	6	3	31	9	22
9	9	7	1	7	15	6	3	22	9	21
10	9	6	1	7	9	6	3	13	9	20
11	9	4	2	7	3	6	3	4	9	19
12	9	2	2	6	57	6	2	54	10	18
13	9	0	2	6	50	7	2	45	9	17
14	8	58	2	6	44	6	2	36	9	16
15	8	56	2	6	37	7	2	26	10	15
16	8	54	2	6	30	7	2	17	9	14
17	8	51	3	6	23	7	2	7	10	13
18	8	49	2	6	16	7	1	57	10	12
19	8	46	3	6	9	8	1	48	9	11
20	8	43	3	6	1	7	1	38	10	10
21	8	40	3	5	54	8	1	28	10	9
22	8	36	4	5	46	7	1	19	9	8
23	8	33	3	5	39	8	1	9	10	7
24	8	29	4	5	31	8	1	0	9	6
25	8	25	4	5	23	8	0	49	10	5
26	8	21	4	5	15	8	0	39	10	4
27	8	17	4	5	7	8	0	30	9	3
28	8	13	4	4	58	8	0	20	10	2
29	8	8	5	4	50	8	0	10	10	1
30	8	4	4	4	42		0	0	10	0
S	8			7			6			S

Annual Equation of MOON's Mean Anomaly.

Argument. The Sun's Mean Anomaly.

S	0			1			2			3			4			5			S
	+		Diff.	+		Diff.	+		Diff.	+		Diff.	+		Diff.	+		Diff.	
0	′	″	″	′	″	″	′	″	″	′	″	″	′	″	″	′	″	″	0
0	0	0	22	10	37	19	18	33	12	21	42	0	19	1	11	11	5	20	30
1	0	22	22	10	56	19	18	45	11	21	42	0	18	50	12	10	45	20	29
2	0	44	22	11	15	19	18	56	10	21	42	1	18	38	12	10	25	21	28
3	1	6	23	11	34	19	19	6	11	21	41	0	18	26	12	10	4	21	27
4	1	29	22	11	53	18	19	17	10	21	41	2	18	14	13	9	43	20	26
5	1	51	22	12	11	19	19	27	10	21	39	1	18	1	13	9	23	21	25
6	2	13	22	12	30	18	19	37	9	21	38	2	17	48	13	9	2	22	24
7	2	35	22	12	48	18	19	46	9	21	36	3	17	35	14	8	40	21	23
8	2	57	22	13	6	17	19	55	9	21	33	2	17	21	14	8	19	22	22
9	3	19	21	13	23	18	20	4	9	21	31	4	17	7	14	7	57	21	21
10	3	40	22	13	41	17	20	13	8	21	27	3	16	53	15	7	36	22	20
11	4	2	22	13	58	17	20	21	7	21	24	4	16	38	15	7	14	22	19
12	4	24	22	14	15	16	20	28	8	21	20	5	16	22	15	6	52	22	18
13	4	46	21	14	31	17	20	36	7	21	15	5	16	8	15	6	30	23	17
14	5	7	22	14	48	16	20	43	6	21	10	5	15	53	16	6	7	22	16
15	5	29	21	15	4	16	20	49	6	21	5	5	15	37	17	5	45	22	15
16	5	50	21	15	20	16	20	55	6	21	0	6	15	20	16	5	23	23	14
17	6	11	22	15	36	15	21	1	5	20	54	7	15	4	17	5	0	23	13
18	6	33	21	15	51	15	21	6	5	20	47	6	14	47	17	4	37	23	12
19	6	54	21	16	6	15	21	11	5	20	41	7	14	30	17	4	14	22	11
20	7	15		16	21		21	16		20	34		14	13		3	52		10

Annual Equation of MOON's Mean Anomaly.

Argument. Sun's Mean Anomaly.

S	0		1		2		3		4		5		S
	+	Diff.	+	Diff.	+	Diff.	+	Diff.	+	Diff.	+	Diff.	
0	′ ″	″	′ ″	″	′ ″	″	′ ″	″	′ ″	″	′ ″	″	°
21	7 36	21	16 36	15	21 21	5	20 26	8	13 55	18	3 29	23	9
22	7 56	20	16 50	14	21 25	4	20 18	8	13 37	18	3 6	23	8
23	8 17	21	17 4	14	21 28	3	20 10	8	13 19	18	2 43	23	7
24	8 37	20	17 17	13	21 31	3	20 1	9	13 1	18	2 19	24	6
25	8 58	21	17 31	14	21 34	3	19 52	9	12 42	19	1 56	23	5
26	9 18	20	17 44	13	21 36	2	19 43	9	12 23	19	1 33	23	4
27	9 38	20	17 57	13	21 38	2	19 33	10	12 4	19	1 10	23	3
28	9 58	20	18 9	12	21 40	2	19 23	10	11 44	20	0 47	23	2
29	10 17	19	18 21	12	21 41	1	19 12	11	11 25	19	0 23	24	1
30	10 37	20	18 33	12	21 42	1	19 1	11	11 5	20	0 0	23	0
	—		—		—		—		—		—		
S	11		10		9		8		7		6		S

I For the MOON's Longitude.

Argument I. Sun's Mean Anomaly.

S	0		1		2		3		4		5		S
	+	Diff.	+	Diff.	+	Diff.	+	Diff.	+	Diff.	+	Diff.	
0	′ ″	″	′ ″	″	′ ″	″	′ ″	″	′ ″	″	′ ″	″	°
0	0 0,0	11,4	5 26,6	9,9	9 31,3	5,9	11 8,6	0,2	9 46,7	5,7	5 42,0	10,3	30
1	0 11,4	11,3	5 36,5	9,7	9 37,2	5,8	11 8,8	0,0	9 41,0	5,9	5 31,7	10,4	29
2	0 22,7	11,4	5 46,2	9,8	9 43,0	5,5	11 8,8	0,2	9 35,1	6,2	5 21,3	10,6	28
3	0 34,1	11,3	5 56,0	9,6	9 48,5	5,4	11 8,6	0,4	9 28,9	6,3	5 10,7	10,6	27
4	0 45,4	11,3	6 5,6	9,5	9 53,9	5,3	11 8,2	0,5	9 22,6	6,5	5 0,1	10,7	26
5	0 56,7	11,3	6 15,1	9,4	9 59,2	5,0	11 7,7	0,9	9 16,1	6,7	4 49,4	10,8	25
6	1 8,0	11,3	6 24,5	9,3	10 4,2	4,9	11 6,8	1,0	9 9,4	6,8	4 38,6	10,9	24
7	1 19,3	11,3	6 33,8	9,1	10 9,1	4,6	11 5,8	1,2	9 2,6	7,0	4 27,7	11,0	23
8	1 30,6	11,2	6 42,9	9,2	10 13,7	4,5	11 4,6	1,4	8 55,6	7,3	4 16,7	11,1	22
9	1 41,8	11,3	6 52,1	8,9	10 18,2	4,4	11 3,2	1,8	8 48,3	7,3	4 5,6	11,2	21
10	1 53,1	11,2	7 1,0	8,8	10 22,6	4,1	11 1,4	1,8	8 41,0	7,6	3 54,4	11,2	20
11	2 4,3	11,1	7 9,8	8,7	10 26,7	4,0	10 59,6	2,0	8 33,4	7,6	3 43,2	11,4	19
12	2 15,4	11,1	7 18,5	8,6	10 30,7	3,7	10 57,6	2,2	8 25,8	7,9	3 31,8	11,3	18
13	2 26,5	11,1	7 27,1	8,5	10 34,4	3,6	10 55,4	2,5	8 17,9	8,0	3 20,5	11,5	17
14	2 37,6	11,0	7 35,6	8,3	10 38,0	3,3	10 52,9	2,6	8 9,9	8,2	3 9,0	11,4	16
15	2 48,6	11,0	7 43,9	8,2	10 41,3	3,2	10 50,3	2,9	8 1,7	8,3	2 57,6	11,6	15
16	2 59,6	10,9	7 52,1	8,0	10 44,5	3,1	10 47,4	3,0	7 53,4	8,5	2 46,0	11,7	14
17	3 10,5	10,9	8 0,1	7,9	10 47,6	2,8	10 44,4	3,3	7 44,9	8,6	2 34,3	11,7	13
18	3 21,4	10,8	8 8,0	7,8	10 50,4	2,6	10 41,1	3,4	7 36,3	8,9	2 22,6	11,7	12
19	3 32,2	10,7	8 15,8	7,6	10 53,0	2,4	10 37,7	3,7	7 27,4	8,8	2 10,9	11,8	11
20	3 42,9	10,7	8 23,4	7,5	10 55,4	2,2	10 34,0	3,8	7 18,6	9,1	1 59,1	11,7	10
21	3 53,6	10,7	8 30,9	7,3	10 57,6	2,0	10 30,2	4,1	7 9,5	9,2	1 47,4	11,8	9
22	4 4,3	10,6	8 38,2	7,2	10 59,6	1,8	10 26,1	4,2	7 0,3	9,3	1 35,6	11,9	8
23	4 14,9	10,5	8 45,4	7,0	11 1,4	1,6	10 21,9	4,5	6 51,0	9,5	1 23,7	12,0	7
24	4 25,4	10,4	8 52,4	6,9	11 3,0	1,5	10 17,4	4,6	6 41,5	9,6	1 11,7	11,9	6
25	4 35,8	10,3	8 59,3	6,7	11 4,5	1,3	10 12,8	4,9	6 31,9	9,7	0 59,8	11,9	5
26	4 46,1	10,2	9 6,0	6,5	11 5,8	1,0	10 7,9	5,0	6 22,2	9,8	0 47,9	12,0	4
27	4 56,3	10,2	9 12,5	6,4	11 6,8	0,8	10 2,9	5,1	6 12,4	10,0	0 35,9	11,9	3
28	5 6,5	10,0	9 18,9	6,3	11 7,6	0,6	9 57,8	5,4	6 2,4	10,1	0 24,0	12,0	2
29	5 16,5	10,1	9 25,2	6,1	11 8,2	0,4	9 52,4	5,7	5 52,3	10,3	0 12,0	12,0	1
30	5 26,6		9 31,3		11 8,6		9 46,7		5 42,0		0 0,0		0
	—		—		—		—		—		—		
S	11		10		9		8		7		6		S

II. For the ☽'s Long.

Argument II. 2☽ à ☉ + Arg. I.

S	0 —	1 —	2 —
	+	+	+
S	6	7	8
	+	+	+
0	″	″	″
0	0,0	28,0	8,4
1	1,0	28,8	48,9
2	2,0	29,6	49,4
3	2,9	30,4	49,8
4	3,9	31,3	50,3
5	4,8	32,1	50,7
6	5,8	32,9	51,1
7	6,8	33,6	51,5
8	7,8	34,4	51,8
9	8,7	35,2	52,2
10	9,7	35,9	52,5
11	10,7	36,7	52,9
12	11,6	37,4	53,2
13	12,6	38,1	53,5
14	13,5	38,8	53,7
15	14,5	39,5	54,0
16	15,4	40,2	54,3
17	16,3	40,9	54,5
18	17,3	41,5	54,7
19	18,2	42,2	54,9
20	19,1	42,8	55,0
21	20,0	43,4	55,2
22	20,9	44,0	55,4
23	21,8	44,6	55,5
24	22,7	45,2	55,6
25	23,6	45,8	55,7
26	24,5	46,4	55,8
27	25,4	46,9	55,8
28	26,2	47,4	55,9
29	27,1	47,9	55,9
30	28,0	48,4	55,9
	+	+	+
S	11	10	9
	—	—	—
S	5	4	3

III. For the ☽'s Long.

Argument III. 2☽ à ☉ — Arg. I.

0 —	1 —	2 —
+	+	+
6	7	8
+	+	+
′ ″	′ ″	′ ″
0 0,0	0 37,8	1 5,2
0 1,3	0 38,8	1 5,9
0 2,6	0 39,9	1 6,5
0 3,9	0 41,0	1 7,1
0 5,3	0 42,1	1 7 7
0 6,6	0 43,2	1 8 3
0 7,9	0 44,3	1 8,5
0 9,2	0 45,3	1 9,3
0 10,5	0 46,4	1 9,8
0 11,8	0 47,4	1 10,3
0 13,1	0 48,4	1 10,8
0 14,4	0 49,4	1 11,2
0 15,7	0 50,4	1 11,6
0 16,9	0 51,4	1 12,0
0 18,2	0 52,3	1 12,4
0 19,5	0 53,3	1 12,7
0 20,8	0 54,2	1 13,1
0 22,0	0 55,1	1 13,4
0 23,3	0 56,0	1 13,7
0 24,5	0 56,8	1 13,9
0 25,8	0 57,7	1 14,2
0 27,0	0 58,5	1 14,4
0 28,2	0 59,3	1 14,6
0 29,4	1 0,1	1 14,7
0 30,6	1 0,9	1 14,9
0 31,8	1 1,7	1 15,0
0 33,0	1 2,4	1 15,1
0 34,2	1 3,2	1 15,2
0 35,4	1 3,9	1 15,3
0 36,5	1 4,6	1 15,3
0 37,7	1 5,2	1 15,3
+	+	+
11	10	9
—	—	—
5	4	3

IV. For the ☽'s Long.

Argument IV. 2☽ à ☉ + ☽'s Me. Ano.

0 +	1 +	2 +	S
6	7	8	
—	—	—	
″	′	′	
0,0	28,9	50,1	30
1,0	29,8	50,6	29
2,0	30,6	51,0	28
3,0	31,5	51,5	27
4,0	32,3	52,0	26
5,0	33,2	52,4	25
6,0	34,0	52,8	24
7,0	34,8	53,2	23
8,0	35,6	53,6	22
9,0	36,4	54,0	21
10,0	37,2	54,3	20
11,0	37,9	54,7	19
12,0	38,7	55,0	18
13,0	39,4	55,3	17
14,0	40,2	55,6	16
15,0	40,9	55,8	15
15,9	41,6	56,1	14
16,9	42,3	56,3	13
17,9	43,0	56,5	12
18,8	43,6	56,7	11
19,8	44,3	56,9	10
20,7	44,9	57,1	9
21,6	45,5	57,2	8
22,6	46,2	57,4	7
23,5	46,8	57,5	6
24,4	47,4	57,6	5
25,3	47,9	57,7	4
26,2	48,5	57,7	3
27,1	49,0	57,8	2
28,0	49,6	57,8	1
28,9	50 1	57,8	0
—	—	—	
+	+	+	
11	10	9	S
+	+	+	
5	4	3	S

V. For the Moon's Longitude. Evection.

Arg. V. 2☽ à ☉ — ☽'s Mean Anomaly.

S	0 —	Dif.	1 —	Dif.	2 —	Dif.	S
0	0 ′ ″	″	0 ′ ″	″	0 ′ ″	″	0
16	0 21 52,2	79,8	0 57 18,2	58,1	1 17 48,5	20,7	14
17	0 23 12,1	79,4	0 58 16,3	57,0	1 18 9,2	19,4	13
18	0 24 31,5	78,9	0 59 13,3	55,9	1 18 28,6	18,0	12
19	0 25 50,4	78,4	1 0 9,2	55,0	1 18 46,6	16,4	11
20	0 27 8,8	78,0	1 1 4,2	53,9	1 19 3,0	15,1	10
21	0 28 26,8	77,5	1 1 58,1	52,6	1 19 18,1	13,6	9
22	0 29 44,3	77,0	1 2 50,7	51,-	1 19 31,7	12,2	8
23	0 31 1,3	76,5	1 3 42,4	50,5	1 19 43,9	10,7	7
24	0 32 17,8	75,9	1 4 32,9	49,3	1 19 54,6	9,3	6
25	0 33 33,7	75,2	1 5 22,2	48,1	1 20 3,9	7,8	5
26	0 34 48,9	74,7	1 6 10,3	47,0	1 20 11,7	6,4	4
27	0 36 3,6	74,1	1 6 57,3	45,8	1 20 18,1	4,9	3
28	0 37 17,7	73,3	1 7 43,1	44,6	1 20 23,0	3,5	2
29	0 38 31,0	72,8	1 8 27,7	43,4	1 20 26,5	1,9	1
30	0 39 42,8		1 9 11,1		1 20 28,4		0
	+		+		+		
S	11		10		9		S

V. For the Moon's Longitude. Evection.

Arg. V. 2☽ à ☉ — ☽'s Mean Anomaly.

S	3 —	Dif.	4 —	Dif.	5 —	Dif.	S
0	0 ′ ″	″	0 ′ ″	″	0 ′ ″	″	0
0	1 20 28,4	0,5	1 10 11,9	42,2	0 40 44,6	74,0	30
1	1 20 28,9	0,9	1 9 29,7	43,4	0 39 30,6	74,7	29
2	1 20 28,0	2,5	1 8 46,3	44,8	0 38 15,9	75,5	28
3	1 20 25,5	4,0	1 8 1,5	46,0	0 37 0,4	76,1	27
4	1 20 21,5	5,4	1 7 15,5	47,3	0 35 44,3	76,8	26
5	1 20 16,1	6,9	1 6 28,2	48,5	0 34 27,5	77,5	25
6	1 20 9,2	8,3	1 5 39,7	49,8	0 33 10,0	78,1	24
7	1 20 0,9	9,8	1 4 49,9	51,0	0 31 51,9	78,8	23
8	1 19 51,1	11,3	1 3 58,9	52,2	0 30 33,1	79,3	22
9	1 19 39,8	12,8	1 3 6,7	53,3	0 29 13,8	79,8	21
10	1 19 27,0	14,2	1 2 13,4	54,6	0 27 54,0	80,4	20
11	1 19 12,8	15,6	1 1 18,8	55,7	0 26 33,6	80,9	19
12	1 18 57,2	17,2	1 0 23,1	56,8	0 25 12,7	81,4	18
13	1 18 40,0	18,5	0 59 26,3	57,9	0 23 51,3	81,8	17
14	1 18 21,5	20,1	0 58 28,4	59,1	0 22 29,5	82,3	16
15	1 18 1,4	21,4	0 57 29,3	60,1	0 21 7,2	82,6	15
16	1 17 40,0	23,0	0 56 29,2	61,2	0 19 44,6	83,0	14
17	1 17 17,0	24,3	0 55 28,0	62,3	0 18 21,6	83,4	13
18	1 16 52,7	25,8	0 54 25,7	63,2	0 16 58,2	83,8	12
19	1 16 26,9	27,1	0 53 22,5	64,3	0 15 34,4	84,0	11
20	1 15 59,8	28,6	0 52 18,2	65,3	0 14 10,4	84,3	10
21	1 15 31,2	30,0	0 51 12,9	66,1	0 12 46,1	84,5	9
22	1 15 1,2	31,3	0 50 6,8	67,2	0 11 21,6	84,7	8
23	1 14 29,9	32,8	0 48 59,6	68,1	0 9 56,9	84,9	7
24	1 13 57,1	34,2	0 47 51,5	69 0	0 8 32,0	85,1	6
25	1 13 22,9	35,5	0 46 42,5	69,9	0 7 6,9	85,2	5
26	1 12 47,4	36,9	0 45 32,6	70,8	0 5 41,7	85,3	4
27	1 12 10,5	38,2	0 44 21,8	71,5	0 4 16,4	85,4	3
28	1 11 32,3	39,5	0 43 10,3	72,5	0 2 51,0	85,5	2
29	1 10 52,8	40,9	0 41 57,8	73,2	0 1 25,5	85,5	1
30	1 10 11,9		0 40 44,6		0 0 0,0		0
	+		+		+		
S	8		7		6		S

V. For the Moon's Longitude. Evection.

Arg. V. 2☽ à ☉ — ☽'s Mean Anomaly.

S	0 —	Dif.	1 —	Dif.	2 —	Dif.	S
0	0 ′ ″	″	0 ′ ″	″	0 ′ ″	″	0
0	0 0 0,0	83,0	0 39 43,8	72,0	1 9 11,1	42,1	30
1	0 1 23,0	83,1	0 40 55,8	71,3	1 9 53,2	40,9	29
2	0 2 46,1	82,9	0 42 7,1	70,5	1 10 34,1	39,6	28
3	0 4 9,0	82,9	0 43 17,6	69,8	1 11 13,7	38,3	27
4	0 5 31,9	82,8	0 44 27,4	69,1	1 11 52,0	37,1	26
5	0 6 54,7	82,7	0 45 36,5	68,2	1 12 29,1	35,8	25
6	0 8 17,4	82,5	0 46 44,7	67,4	1 13 4,9	34,4	24
7	0 9 39,9	82,4	0 47 52,1	66,5	1 13 39,3	33,1	23
8	0 11 2,3	82,2	0 48 58,6	65,7	1 14 12,4	31,8	22
9	0 12 24,5	82,0	0 50 4,3	64,7	1 14 44,2	30,4	21
10	0 12 46,5	81,7	0 51 9,0	63,9	1 15 14,6	29,1	20
11	0 15 8,2	81,4	0 52 12,9	63,0	1 15 43,7	27,8	19
12	0 16 29,6	81,2	0 53 15,9	62,1	1 16 11,5	26,3	18
13	0 17 50,8	80,8	0 54 18,0	61,0	1 16 37,8	25,0	17
14	0 19 11,6	80,6	0 55 19,0	60,1	1 17 2,8	23,6	16
15	0 20 32,2	80,1	0 56 19,1	59,1	1 17 26,4	22,1	15

VI. For the ☽'s Long.

Argument VI. Arg. V + Arg. I.

S	0 +	1 +	2 +	S
	6 —	7 —	8 —	
0	° ′	° ′	° ′	0
0	0,0	1 1,8	1 47,0	30
1	2,2	1 3,6	1 48,0	29
2	4,3	1 5,4	1 49,0	28
3	6,5	1 7,3	1 50,0	27
4	8,6	1 9,1	1 51,0	26
5	10,8	1 10,8	1 51,9	25
6	12,9	1 12,6	1 52,8	24
7	15,1	1 14,3	1 53,7	23
8	17,2	1 16,0	1 54,5	22
9	19,3	1 17,7	1 55,3	21
10	21,5	1 19,4	1 56,1	20
11	23,6	1 21,0	1 56,8	19
12	25,7	1 22,6	1 57,5	18
13	27,8	1 24,2	1 58,1	17
14	29,9	1 25,8	1 58,7	16
15	32,0	1 27,3	1 59,3	15
16	34,1	1 28,8	1 59,8	14
17	36,1	1 30,3	2 0,3	13
18	38,2	1 31,8	2 0,8	12
19	40,2	1 33,2	2 1,2	11
20	42,2	1 34,6	2 1,6	10
21	44,3	1 36,0	2 2,0	9
22	46,3	1 37,3	2 2,3	8
23	48,3	1 38,6	2 2,6	7
24	50,2	1 39,9	2 2,8	6
25	52,2	1 41,2	2 3,0	5
26	54,1	1 42,4	2 3,2	4
27	56,1	1 43,6	2 3,3	3
28	58,0	1 44,7	2 3,4	2
29	59,9	1 45,9	2 3,5	1
30	1 1,8	1 47,0	2 3,5	0
	—	—	—	
S	11	10	9	S
	+	+	+	
S	5	4	3	S

VII. For ☽ Lv.

Argu. VII. Arg. V − Arg. I

0 +	1 +	2 +	S
6 —	7 —	8 —	
″	″	″	
0,0	23,3	40,3	30
0,8	24,0	40,7	29
1,6	24,7	41,1	28
2,4	25,3	41,4	27
3,2	26,0	41,8	26
4,1	26,7	42,2	25
4,9	27,3	42,5	24
5,7	28,0	42,8	23
6,5	28,6	43,1	22
7,3	29,3	43,4	21
8,1	29,9	43,7	20
8,9	30,5	44,0	19
9,7	31,1	44,2	18
10,5	31,7	44,5	17
11,3	32,3	44,7	16
12,0	32,9	44,9	15
12,8	33,5	45,1	14
13,6	34,0	45,3	13
14,4	34,6	45,5	12
15,1	35,1	45,7	11
15,9	35,6	45,8	10
16,7	36,2	45,9	9
17,4	36,7	46,1	8
18,2	37,1	46,2	7
18,9	37,6	46,3	6
19,7	38,1	46,3	5
20,4	38,6	46,4	4
21,1	39,0	46,4	3
21,8	39,4	46,5	2
22,6	39,9	46,5	1
23,3	40,3	46,5	0
—	—	—	
11	10	9	S
+	+	+	
5	4	3	S

VIII. For ☽'s Lo.

Argument VIII. ☽ M. An. − Ar. I.

0 +	1 +	2 +	S
6 —	7 —	8 —	
″	″	″	
0,0	21,0	36,4	30
0,7	21,6	36,7	29
1,5	22,3	37,1	28
2,2	22,9	37,4	27
2,9	23,5	37,8	26
3,7	24,1	38,1	25
4,4	24,7	38,4	24
5,1	25,3	38,7	23
5,9	25,9	38,9	22
6,6	26,4	39,2	21
7,3	27,0	39,5	20
8,0	27,6	39,7	19
8,7	28,1	39,9	18
9,5	28,7	40,2	17
10,2	29,2	40,4	16
10,9	29,7	40,6	15
11,6	30,2	40,8	14
12,3	30,7	40,9	13
13,0	31,2	41,1	12
13,7	31,7	41,2	11
14,4	32,2	41,4	10
15,1	32,6	41,5	9
15,7	33,1	41,6	8
16,4	33,5	41,7	7
17,1	34,0	41,8	6
17,8	34,4	41,8	5
18,4	34,8	41,9	4
19,1	35,2	41,9	3
19,7	35,6	42,0	2
20,4	36,0	42,0	1
21,0	36,4	42,0	0
—	—	—	
11	10	9	S
+	+	+	
5	4	3	S

IX. For the Moon's Longitude.

Arg. IX. Mean Dist. ☽ à ☉ — ☽'s Mean Anomaly.

S	0 —	Diff.	1 —	Diff.	2 ∓	Diff.	S
0	° ′ ″	″	° ′ ″	″	° ′ ″	″	0
0	0 0,0	1,6	0 38,3	0,7	0 30,0	1,2	30
1	0 1,6	1,6	0 39,0	0,6	0 28,8	1,2	29
2	0 3,2	1,6	0 39,6	0,4	0 27,6	1,3	28
3	0 4,8	1,6	0 40,0	0,5	0 26,3	1,5	27
4	0 6,4	1,6	0 40,5	0,4	0 24,8	1,4	26
5	0 8,0	1,5	0 40,9	0,4	0 23,4	1,4	25
6	0 9,5	1,6	0 41,3	0,2	0 22,0	1,6	24
7	0 11,1	1,5	0 41,5	0,2	0 20,4	1,6	23
8	0 12,6	1,5	0 41,7	0,2	0 18,8	1,6	22
9	0 14,1	1,6	0 41,9	0,0	0 17,2	1,6	21
10	0 15,7	1,5	0 41,9	0,0	0 15,6	1,8	20
11	0 17,2	1,5	0 41,9	0,0	0 13,8	1,7	19
12	0 18,7	1,4	0 41,9	0,1	0 12,1	1,7	18
13	0 20,1	1,4	0 41,8	0,2	0 10,4	1,8	17
14	0 21,5	1,3	0 41,6	0,3	0 8,6	1,8	16
15	0 22,8		0 41,3		0 6,8		15

IX. For the Moon's Longitude.

Arg. IX. Mean Dist. ☽ à ☉ — ☽'s Mean Anomaly.

S	0 —	Diff.	1 —	Diff.	2 ∓	Diff.	S
0	° ′ ″	″	° ′ ″	″	° ′ ″	″	0
16	0 24,1	1,3	0 41,1	0,2	0 5,0	1,8	14
17	0 25,5	1,4	0 40,7	0,4	0 3,1	1,9	13
18	0 26,7	1,2	0 40,2	0,5	0 1,2	1,9	12
19	0 27,9	1,2	0 39,7	0,5	0 0,8	2,0	11
20	0 29,1	1,2	0 39,1	0,6	0 2,8	2,0	10
21	0 30,3	1,2	0 38,5	0,6	0 4,7	1,9	9
22	0 31,4	1,1	0 37,8	0,7	0 6,7	2,0	8
23	0 32,4	1,0	0 37,1	0,7	0 8,6	1,9	7
24	0 33,5	1,1	0 36,2	0,9	0 10,7	2,1	6
25	0 34,4	0,9	0 35,3	0,9	0 12,6	1,9	5
26	0 35,2	0,8	0 34,4	0,9	0 14,6	2,0	4
27	0 36,1	0,9	0 33,4	1,0	0 16,7	2,1	3
28	0 36,9	0,8	0 32,3	1,1	0 18,7	2,0	2
29	0 37,7	0,8	0 31,2	1,1	0 20,7	2,0	1
30	0 38,3	0,6	0 30,0	1,2	0 22,7	2,0	0
	+		+		∓		
S	11		10		9		S

IX. For the Moon's Longitude.

Arg. IX. Mean Dist. ☽ à ☉ — ☽'s Mean Anomaly.

S	3 +	Diff.	4 +	Diff.	5 +	Diff.	S
0	° ′ ″	″	° ′ ″	″	° ′ ″	″	0
0	0 22,7	2,0	1 9,4	0,8	1 1,1	1,4	30
1	0 24,7	2,0	1 10,2	0,7	0 59,7	1,4	29
2	0 26,7	2,0	1 10,9	0,5	0 58,3	1,5	28
3	0 28,7	1,9	1 11,4	0,6	0 56,8	1,6	27
4	0 30,6	2,0	1 12,0	0,5	0 55,2	1,6	26
5	0 32,6	1,8	1 12,5	0,5	0 53,6	1,7	25
6	0 34,4	2,0	1 13,0	0,3	0 51,9	1,7	24
7	0 36,4	1,9	1 13,3	0,3	0 50,2	1,8	23
8	0 38,3	1,8	1 13,6	0,2	0 48,4	1,9	22
9	0 40,1	1,9	1 13,8	0,1	0 46,5	1,8	21
10	0 42,0	1,8	1 13,9	0,0	0 44,7	2,0	20
11	0 43,8	1,8	1 13,9	0,1	0 42,7	2,0	19
12	0 45,6	1,7	1 14,0	0,1	0 40,7	2,0	18
13	0 47,3	1,7	1 13,9	0,2	0 38,7	2,0	17
14	0 49,0	1,6	1 13,7	0,2	0 36,7	2,1	16
15	0 50,6	1,6	1 13,5	0,3	0 34,6	2,1	15
16	0 52,2	1,6	1 13,2	0,4	0 32,5	2,2	14
17	0 53,8	1,5	1 12,8	0,5	0 30,3	2,2	13
18	0 55,3	1,5	1 12,3	0,6	0 28,1	2,3	12
19	0 56,8	1,4	1 11,7	0,6	0 25,8	2,3	11
20	0 58,2	1,4	1 11,1	0,6	0 23,5	2,2	10
21	0 59,6	1,4	1 10,5	0,8	0 21,3	2,3	9
22	1 1,0	1,2	1 9,7	0,8	0 19,0	2,3	8
23	1 2,2	1,2	1 8,9	1,0	0 16,7	2,4	7
24	1 3,4	1,2	1 7,9	1,0	0 14,3	2,3	6
25	1 4,6	1,0	1 6,9	1,0	0 12,0	2,4	5
26	1 5,6	1,0	1 5,9	1,1	0 9,6	2,4	4
27	1 6,6	1,0	1 4,8	1,2	0 7,2	2,4	3
28	1 7,6	1,0	1 3,6	1,2	0 4,8	2,4	2
29	1 8,6	1,0	1 2,4	1,3	0 2,4	2,4	1
30	1 9,4	0,8	1 1,1		0 0,0		0
	—		—		—		
S	8		7		6		S

X. For the ☽'s Long.

Argument X. M. Lo. ☌ — True Lon.

S	0	1	2
	+	+	+
S	6	7	8
	—	+	+
°	′	″	″	′	″
---	---	---	---	---	---
0	0	0,0	52,3	0	52,3
1	0	2,1	53,3	0	51,2
2	0	4,2	54,3	0	50,1
3	0	6,3	55,2	0	48,9
4	0	8,4	56,0	0	47,6
5	0	10,5	56,8	0	46,3
6	0	12,6	57,4	0	44,9
7	0	14,6	58,0	0	43,5
8	0	16,7	58,6	0	42,0
9	0	18,7	59,1	0	40,4
10	0	20,7	59,5	0	38,8
11	0	22,6	59,8	0	37,2
12	0	24,6	1	0,1	0	35,5
13	0	26,5	1	0,2	0	33,8
14	0	28,4	1	0,4	0	32,0
15	0	30,2	1	0,4	0	30,2
16	0	32,0	1	0,4	0	28,4
17	0	33,8	1	0,3	0	26,5
18	0	35,5	1	0,1	0	24,6
19	0	37,2	0	59,8	0	22,6
20	0	38,8	0	59,5	0	20,7
21	0	40,4	0	59,1	0	18,7
22	0	42,0	0	58,6	0	16,7
23	0	43,5	0	58,0	0	14,6
24	0	44,9	0	57,4	0	12,6
25	0	46,3	0	56,8	0	10,5
26	0	47,6	0	56,0	0	8,4
27	0	48,9	0	55,2	0	6,2
28	0	50,1	0	54,3	0	4,2
29	0	51,2	0	53,3	0	2,1
30	0	52,3	0	52,3	0	0,0
S	—	—	—			
	11	10	9			
S	—	—	—			
	5	4	3			

XI. For ☽ Lo.

Argum. XI. ☽ à ☉ + ☉ An.

0	1	2
—	—	—
6	7	8
+	+	+
″	′	′
---	---	---	---
0	0,0	8,5	14,7
1	0,3	8,8	14,9
2	0,6	9,0	15,0
3	0,9	9,3	15,2
4	1,2	9,5	15,3
5	1,5	9,8	15,4
6	1,8	10,0	15,5
7	2,1	10,2	15,6
8	2,4	10,5	15,8
9	2,7	10,7	15,9
10	3,0	10,9	16,0
11	3,3	11,2	16,1
12	3,5	11,4	16,2
13	3,8	11,6	16,3
14	4,1	11,8	16,3
15	4,4	12,0	16,4
16	4,7	12,2	16,5
17	5,0	12,4	16,6
18	5,3	12,6	16,6
19	5,5	12,8	16,7
20	5,8	13,0	16,7
21	6,1	13,2	16,8
22	6,4	13,4	16,8
23	6,6	13,6	16,9
24	6,9	13,8	16,9
25	7,2	13,9	16,9
26	7,5	14,1	17,0
27	7,7	14,3	17,0
28	8,	14,4	17,0
29	8,2	14,6	17,0
30	8,5	14,7	17,0
	+	+	+
S	11	10	9
	—	—	—
S	5	4	3

XII. For ☽ Lon.

Argument XII. ☽ à ☉ — ☉ Ano.

0	1	2
—	—	—
6	7	8
+	+	+
″	″	″
---	---	---	---
0	0,0	1,6	2,7	30
1	0,1	1,6	2,7	29
2	0,2	1,6	2,7	28
3	0,2	1,7	2,8	27
4	0,3	1,7	2,8	26
5	0,3	1,8	2,8	25
6	0,4	1,8	2,8	24
7	0,4	1,9	2,9	23
8	0,5	1,9	2,9	22
9	0,5	2,0	2,9	21
10	0,6	2,0	2,9	20
11	0,7	2,0	2,9	19
12	0,7	2,1	3,0	18
13	0,8	2,1	3,0	17
14	0,8	2,2	3,0	16
15	0,9	2,2	3,0	15
16	0,9	2,2	3,0	14
17	0,9	2,3	3,0	13
18	1,0	2,3	3,0	12
19	1,0	2,3	3,0	11
20	1,1	2,4	3,1	10
21	1,1	2,4	3,1	9
22	1,2	2,4	3,1	8
23	1,2	2,5	3,1	7
24	1,3	2,5	3,1	6
25	1,3	2,5	3,1	5
26	1,4	2,6	3,1	4
27	1,4	2,6	3,1	3
28	1,5	2,6	3,1	2
29	1,5	2,7	3,1	1
30	1,6	2,7	3,1	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

XIII. For the ☽'s Long.

Argument XIII. 2 ☽ à ☉ + 2 ☽'s M. Ano.

S	0	1	2
	—	—	—
S	6	7	8
	+	+	+
°	″	′	″
0	0,0	1,9	3,2
1	0,1	1,9	3,2
2	0,1	2,0	3,3
3	0,2	2,0	3,3
4	0,3	2,1	3,3
5	0,3	2,1	3,4
6	0,4	2,2	3,4
7	0,5	2,2	3,4
8	0,5	2,3	3,4
9	0,6	2,3	3,5
10	0,6	2,4	3,5
11	0,7	2,4	3,5
12	0,8	2,5	3,5
13	0,8	2,5	3,5
14	0,9	2,6	3,6
15	1,0	2,6	3,6
16	1,0	2,7	3,6
17	1,1	2,7	3,6

XIV. For ☽ Lo.

Arg. XIV. 4 ☽ à ☉ — ☽ M. A

0	1	2
+	+	+
6	7	8
—	—	—
″	″	″
---	---	---	---
0	0,0	6,2	10,7
1	0,2	6,4	10,8
2	0,4	6,6	11,0
3	0,6	6,8	11,1
4	0,9	6,9	11,2
5	1,1	7,1	11,2
6	1,3	7,3	11,3
7	1,5	7,5	11,4
8	1,7	7,6	11,5
9	1,9	7,8	11,6
10	2,2	8,0	11,7
11	2,4	8,1	11,7
12	2,6	8,3	11,8
13	2,8	8,5	11,9
14	3,0	8,6	11,9
15	3,2	8,8	12,0
16	3,4	8,9	12,
17	3,6	9,1	12,

XV. For ☽'s Lon.

Arg. XV. 2 ☽ à ☌ — 2 ☽'s M.A

0	1	2
—	—	—
6	7	8
+	+	+
″	″	″
---	---	---	---
0	0,0	3,2	5,5	30
1	0,1	3,2	5,5	29
2	0,2	3,3	5,6	28
3	0,3	3,4	5,6	27
4	0,4	3,5	5,7	26
5	0,6	3,6	5,7	25
6	0,7	3,7	5,8	24
7	0,8	3,8	5,8	23
8	0,9	3,9	5,8	22
9	1,0	4,0	5,9	21
10	1,1	4,1	5,9	20
11	1,2	4,1	6,0	19
12	1,3	4,2	6,0	18
13	1,4	4,3	6,0	17
14	1,5	4,4	6,	16
15	1,6	4,5	6,	15
16	1,7	4,5	6,	14
17	1,8	4,6	6,	13

XIII. For the ☽'s Long.

Argument XIII. 2 ☽ à ☉ + 2 ☽'s M. Ano.

S	0	1	2
	—	—	—
S	6	7	8
	+	+	+
°	″	′	″
18	1,1	2,8	3,6
19	1,2	2,8	3,6
20	1,3	2,8	3,6
21	1,3	2,9	3,7
22	1,4	2,9	3,7
23	1,4	3,0	3,7
24	1,5	3,0	3,7
25	1,6	3,0	3,7
26	1,6	3,1	3,7
27	1,7	3,1	3,7
28	1,7	3,1	3,7
29	1,8	3,2	3,7
30	1,9	2,2	3,7
	+	+	+
S	11	10	9
	—	—	—
S	5	4	3

XIV. For ☽'s Lon.

Argument XIV. 4 ☽ à ☉ — ☽'s M.A.

0	1	2
+	+	+
6	7	8
—	—	—
″	″	″
---	---	---	---
18	3,8	9,2	12,1
19	4,0	9,4	12,2
20	4,2	9,5	12,2
21	4,5	9,6	12,2
22	4,7	9,8	12,3
23	4,9	9,9	12,3
24	5,0	10,0	12,3
25	5,2	10,2	12,3
26	5,4	10,3	12,4
27	5,6	10,3	12,4
28	5,8	10,5	12,4
29	6,0	10,6	12,4
30	6,2	10,7	12,4
	—	—	—
S	11	10	9
	+	+	+
S	5	4	3

XV. For the ☽'s Lon.

Argument XV. 2 ☽ à ☌ — 2 ☽'s M. A.

0	1	2
—	—	—
6	7	8
+	+	+
″	″	″
---	---	---	---
0	2,0	4,7	6,2	12
1	2,1	4,8	6,2	11
2	2,2	4,8	6,2	10
3	2,3	4,9	6,2	9
4	2,4	5,0	6,2	8
5	2,5	5,0	6,3	7
6	2,6	5,1	6,3	6
7	2,7	5,2	6,3	5
8	2,8	5,2	6,3	4
9	2,9	5,3	6,3	3
10	3,0	5,3	6,3	2
11	3,1	5,4	6,3	1
12	3,2	5,5	6,3	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

XVI. For the ☽'s Long.

Argument XVI. 2 ☽ à ☉ — 2 ☽ à ☌ + ☽ M. A.

S	0	1	2
	+	+	+
S	6	7	8
	—	—	—
°	″	″	″
0	0,0	4,2	7,2
1	0,2	4,3	7,3
2	0,3	4,4	7,3
3	0,4	4,5	7,4
4	0,6	4,7	7,5
5	0,7	4,8	7,5
6	0,9	4,9	7,6
7	1,0	5,0	7,7
8	1,2	5,1	7,7
9	1,3	5,2	7,8
10	1,4	5,3	7,8
11	1,6	5,5	7,9
12	1,7	5,6	7,9
13	1,9	5,7	8,0
14	2,0	5,8	8,0
15	2,2	5,9	8,0
16	2,3	6,0	8,1
17	2,4	6,1	8,1
18	2,6	6,2	8,1
19	2,7	6,3	8,2
20	2,8	6,4	8,2
21	3,0	6,5	8,2
22	3,1	6,6	8,2
23	3,3	6,6	8,2
24	3,4	6,7	8,3
25	3,5	6,8	8,3
26	3,6	6,9	8,3
27	3,8	7,0	8,3
28	3,9	7,0	8,3
29	4,0	7,1	8,3
30	4,2	7,2	8,3
	+	+	+
S	5	4	3
	—	—	—
S	11	10	9

XVII. For ☽'s Lon.

Argument XVII. 2 ☽ á ☉ — 2 ☽ á ☌ — ☽'s M. A.

0	1	2
—	—	—
6	7	8
+	+	+
″	″	″
---	---	---	---
0	0,0	2,7	4,6
1	0,1	2,7	4,6
2	0,3	2,8	4,7
3	0,3	2,9	4,7
4	0,4	3,0	4,8
5	0,5	3,1	4,8
6	0,6	3,1	4,9
7	0,7	3,2	4,9
8	0,7	3,3	4,9
9	0,8	3,3	5,0
10	0,9	3,4	5,0
11	1,0	3,5	5,0
12	1,1	3,6	5,0
13	1,2	3,6	5,1
14	1,3	3,7	5,1
15	1,4	3,8	5,1
16	1,5	3,8	5,2
17	1,6	3,9	5,2
18	1,6	3,9	5,2
19	1,7	4,0	5,2
20	1,8	4,1	5,2
21	1,9	4,1	5,2
22	2,0	4,2	5,3
23	2,1	4,2	5,3
24	2,2	4,3	5,3
25	2,2	4,3	5,3
26	2,3	4,4	5,3
27	2,4	4,5	5,3
28	2,5	4,5	5,3
29	2,6	4,5	5,3
30	2,7	4,6	5,3
	—	—	—
S	5	4	3
	+	+	+
S	11	10	9

XVIII. For ☽'s Long.

Argument XVIII. Mean Long. ☽'s ☌

0	1	2
+	+	+
6	7	8
—	—	—
″	″	″
---	---	---	---
0	0,0	3,9	6,7	30
1	0,1	4,0	6,7	29
2	0,3	4,1	6,8	28
3	0,4	4,2	6,8	27
4	0,5	4,3	6,9	26
5	0,7	4,4	7,0	25
6	0,8	4,5	7,0	24
7	1,0	4,6	7,1	23
8	1,1	4,7	7,1	22
9	1,2	4,8	7,2	21
10	1,3	5,0	7,2	20
11	1,5	5,1	7,3	19
12	1,6	5,2	7,3	18
13	1,7	5,3	7,4	17
14	1,9	5,4	7,4	16
15	2,0	5,4	7,4	15
16	2,1	5,5	7,5	14
17	2,2	5,6	7,5	13
18	2,4	5,7	7,5	12
19	2,5	5,8	7,5	11
20	2,6	5,9	7,6	10
21	2,8	6,0	7,6	9
22	2,9	6,1	7,6	8
23	3,0	6,1	7,6	7
24	3,1	6,2	7,7	6
25	3,3	6,3	7,7	5
26	3,4	6,4	7,7	4
27	3,5	6,5	7,7	3
28	3,6	6,5	7,7	2
29	3,7	6,6	7,7	1
30	3,9	6,7	7,7	0
	+	+	+	
S	5	4	3	S
	—	—	—	
S	11	10	9	S

XIX. For the MOON's Longitude. Equation Center.

Argument XIX. Moon's Correct Anomaly.

S	0				1				2				S
	—			Diff.	—		Diff.		—		Diff.		
°	°	′	″	′ ″	°	′	″	′ ″	°	′	″	′ ″	°
0	0	0	0,0	6 10,9	2	58	30,5	5 28,1	5	16	20,9	3 27,1	30
1	0	6	10,9	6 10,7	3	3	58,6	5 25,2	5	19	48,0	3 21,9	29
2	0	12	21,6	6 10,6	3	9	23,8	5 22,4	5	23	9,9	3 16,6	28
3	0	18	32,2	6 10,3	3	14	46,2	5 19,2	5	26	26,5	3 11,2	27
4	0	24	42,5	6 9,9	3	20	5,4	5 16,3	5	29	37,7	3 5,6	26
5	0	30	52,4	6 9,4	3	25	21,7	5 13,1	5	32	43,3	3 0,2	25
6	0	37	1,8	6 8,9	3	30	34,8	5 9,9	5	35	43,5	2 54,7	24
7	0	43	10,7	6 8,3	3	35	44,7	5 6,5	5	38	38,2	2 49,1	23
8	0	49	19,0	6 7,5	3	40	51,2	5 3,1	5	41	27,3	2 43,3	22
9	0	55	26,5	6 6,7	3	45	54,3	4 59,5	5	44	10,6	2 37,5	21
10	1	1	33,2	6 5,8	3	50	53,8	4 55,9	5	46	48,1	2 31,7	20
11	1	7	39,0	6 4,8	3	55	49,7	4 52,3	5	49	19,8	2 25,7	19
12	1	13	43,8	6 3,5	4	0	42,0	4 48,5	5	51	45,5	2 19,8	18
13	1	19	47,3	6 2,4	4	5	30,5	4 44,7	5	54	5,3	2 13,9	17
14	1	25	49,7	6 1,2	4	10	15,2	4 40,7	5	56	19,2	2 7,7	16
15	1	31	50,9	5 59,7	4	14	55,9	4 36,7	5	58	26,9	2 1,6	15
16	1	37	50,6	5 58,1	4	19	32,6	4 32,7	6	0	28,5	1 55,4	14
17	1	43	48,7	5 56,8	4	24	5,3	4 28,4	6	2	23,9	1 49,1	13
18	1	49	45,5	5 55,1	4	28	33,7	4 24,1	6	4	13,0	1 42,8	12
19	1	55	40,6	5 53,2	4	32	57,8	4 19,9	6	5	55,8	1 36,5	11
20	2	1	33,8	5 51,4	4	37	17,7	4 15,5	6	7	32,3	1 30,1	10
21	2	7	25,2	5 49,6	4	41	33,2	4 11,0	6	9	2,4	1 23,7	9
22	2	13	14,8	5 47,5	4	45	44,2	4 6,4	6	10	26,1	1 17,2	8
23	2	19	2,3	5 45,3	4	49	50,6	4 1,7	6	11	43,3	1 10,7	7
24	2	24	47,6	5 43,2	4	53	52,3	3 57,0	6	12	54,0	1 4,0	6
25	2	30	30,8	5 40,9	4	57	49,3	3 52,2	6	13	58,0	0 57,4	5
26	2	36	11,7	5 38,5	5	1	41,5	3 47,4	6	14	55,4	0 50,7	4
27	2	41	50,2	5 36,0	5	5	28,9	3 42,4	6	15	46,1	0 44,0	3
28	2	47	26,2	5 33,4	5	9	11,3	3 37,3	6	16	30,1	0 37,3	2
29	2	52	59,6	5 30,9	5	12	48,6	3 32,3	6	17	7,4	0 30,6	1
30	2	58	30,5		5	16	20,9		6	17	38,0		0
	+				+				+				
S	11				10				9				S

XIX. For the MOON's Longitude. Equation Center.

Argument XIX. Moon's Correct Anomaly.

S	3				4				5				S
	—			Diff.	—		Diff.		—		Diff.		
°	°	′	″	′ ″	°	′	″	′ ″	°	′	″	′ ″	°
0	6	17	380,	0 23,6	5	38	46,5	3 5,9	3	20	56,1	5 58,7	30
1	6	18	1,6	0 16,9	5	35	40,6	3 12,7	3	14	57,4	6 3,0	29
2	6	18	18,5	0 10,0	5	32	27,9	3 19,4	3	8	54,4	6 7,2	28
3	6	18	28,5	0 3,1	5	29	8,5	3 26,2	3	2	47,2	6 11,1	27
4	6	18	31,6	0 3,8	5	25	42,3	3 32,7	2	56	36,1	6 14,9	26
5	6	18	27,8	0 10,8	5	22	9,6	3 39,5	2	50	21,2	6 18,8	25
6	6	18	17,0	0 17,7	5	18	30,1	3 45,9	2	44	2,4	6 22,3	24
7	6	17	59,2	0 24,8	5	14	44,2	3 52,4	2	37	40,1	6 25,9	23
8	6	17	34,5	0 31,9	5	10	51,8	3 58,8	2	31	14,2	6 29,2	22
9	6	17	2,6	0 38,9	5	6	52,0	4 5,1	2	24	45,0	6 32,4	21
10	6	16	23,7	0 45,9	5	2	47,9	4 11,2	2	18	12,6	6 35,4	20
11	6	15	37,8	0 52,8	4	58	36,6	4 17,5	2	11	37,2	6 38,3	19
12	6	14	45,0	0 59,9	4	54	19,1	4 23,8	2	4	58,9	6 41,2	18
13	6	13	45,1	1 7,2	4	49	55,3	4 29,9	1	58	17,7	6 43,7	17
14	6	12	37,9	1 14,0	4	45	25,4	4 35,7	1	51	34,0	6 46,2	16
15	6	11	23,9	1 21,3	4	40	40,7	4 41,7	1	44	47,7	6 48,6	15
16	6	10	2,6	1 28,3	4	36	8,0	4 47,5	1	37	59,1	6 50,6	14
17	6	8	34,3	1 35,4	4	31	20,5	4 53,1	1	31	8,5	6 52,7	13
18	6	6	58,9	1 42,5	4	26	27,4	4 58,8	1	24	15,8	6 54,8	12
19	6	5	16,4	1 49,5	4	21	28,6	5 4,6	1	17	21,0	6 56,4	11
20	6	3	26,9	1 56,5	4	16	24,0	5 9,9	1	10	24,6	6 57,9	10

XIX. For the MOON's Longitude. Equation Center.

Argument XIX. Moon's Correct Anomaly.

S	3				4				5				S
	—			Diff.	—		Diff.		—		Diff.		
°	°	′	″	′ ″	°	′	″	′ ″	°	′	″	′ ″	°
21	6	1	30,4	2 3,7	4	11	14,1	5 15,3	1	3	26,7	6 59,4	9
22	5	59	26,7	2 10,7	4	5	58,8	5 20,5	0	56	27,3	7 0,6	8
23	5	57	16,0	2 17,7	4	0	38,3	5 25,7	0	49	26,7	7 1,8	7
24	5	54	58,3	2 24,6	3	55	12,6	5 30,6	0	42	24,9	7 2,7	6
25	5	52	33,7	2 31,6	3	49	42,0	5 35,8	0	35	22,2	7 3,5	5
26	5	50	2,1	2 38,6	3	44	6,2	5 40,4	0	28	18,7	7 4,1	4
27	5	47	23,5	2 45,4	3	38	25,8	5 45,4	0	21	14,6	7 4,6	3
28	5	44	38,1	2 52,3	3	32	40,4	5 49,8	0	14	10,0	7 4,9	2
29	5	41	45,8	2 59,3	3	26	50,6	5 54,5	0	7	5,1	7 5,1	1
30	5	38	46,5		3	20	56,1		0	0	0,0		0
					+				+				
S	8				7				6				S

XX. For the MOON's Longitude. Variation.

Argument XX. ☽'s Equated Long. — ☉'s true Long

S	0			1			2			S
	+		Diff.	+		Diff.	+		Diff.	
°	′	″	″	′	″	″	′	″	″	°
0	0	0,0	73,6	30	8,7	34,3	29	6,1	40,0	30
1	1	13,6	73,4	30	43,0	31,8	28	26,1	42,2	29
2	2	27,0	73,3	31	14,8	29,4	27	43,9	44,3	28
3	3	40,3	73,0	31	44,2	27,1	26	59,6	46,4	27
4	4	53,3	72,7	32	11,3	24,5	26	13,2	48,3	26
5	6	6,0	72,1	32	35,8	22,3	25	24,9	50,2	25
6	7	18,1	71,6	32	58,1	19,6	24	34,7	52,0	24
7	8	29,7	71,0	33	17,7	17,0	23	42,7	53,9	23
8	9	40,7	70,2	33	34,7	14,6	22	48,8	55,7	22
9	10	50,9	69,3	33	49,3	12,0	21	53,1	57,2	21
10	12	0,2	68,5	34	1,3	9,5	20	55,9	58,9	20
11	13	8,7	67,5	34	10,8	6,8	19	57,0	60,4	19
12	14	16,2	66,4	34	17,6	4,2	18	56,6	61,8	18
13	15	22,6	65,1	34	21,8	1,7	17	54,8	63,2	17
14	16	27,7	63,8	34	23,5	0,9	16	51,6	64,5	16
15	17	31,5	62,7	34	22,6	3,5	15	47,1	65,7	15
16	18	34,2	61,2	34	19,1	6,1	14	41,4	66,9	14
17	19	35,4	59,6	34	13,0	8,7	13	34,5	68,1	13
18	20	35,0	58,2	34	4,3	11,4	12	26,4	69,0	12
19	21	33,2	56,4	33	52,9	13,7	11	17,4	69,6	11
20	22	29,6	54,7	33	39,2	16,4	10	7,8	70,8	10
21	23	24,3	52,9	33	22,8	18,8	8	57,0	71,5	9
22	24	17,2	51,2	33	4,0	21,4	7	45,5	71,9	8
23	25	8,4	49,0	32	42,6	23,9	6	33,6	72,7	7
24	25	57,4	47,2	32	18,7	26,1	5	20,9	73,0	6
25	26	44,6	45,2	31	52,6	28,7	4	7,9	73,5	5
26	27	29,8	42,9	31	23,9	31,0	2	54,4	73,7	4
27	28	12,7	41,1	30	52,9	33,4	1	40,7	74,0	3
28	28	53,8	38,6	30	19,5	35,5	0	26,7	74,2	2
29	29	32,4	36,3	29	44,0	37,9	0	47,5	74,1	1
30	30	8,7		29	6,1		2	1,6		0
	—			—			+			
S	11			10			9			S

XX. For the Moon's Longitude. Variation.

Arg. XX. ☽'s Equated Lon. — ☉'s True Lo.

S	3 —	Diff.	4 —	Diff.	5 —	Diff.	S
0	′ ″	″	′ ″	″	′ ″	″	0
0	2 1,6	74,1	32 27,7	35,3	31 54,7	39,9	30
1	3 15,7	74,0	33 3,0	32,9	31 14,8	42,2	29
2	4 29,7	73,6	33 35,9	30,6	30 32,6	44,3	28
3	5 43,3	73,5	34 6,5	28,2	29 48,3	46,7	27
4	6 56,8	73,1	34 34,7	25,9	29 1,6	48,6	26
5	8 9,9	72,6	35 0,6	23,3	28 13,0	50,8	25
6	9 22,5	71,9	35 23,9	20,9	27 22,2	52,7	24
7	10 34,4	71,3	35 44,8	18,4	26 29,5	54,7	23
8	11 45,7	70,5	36 3,2	15,8	25 34,8	56,3	22
9	12 56,2	69,8	36 19,0	13,4	24 38,5	58,3	21
10	14 6,0	68,8	36 32,4	10,7	23 40,2	60,0	20
11	15 14,8	67,8	36 43,1	8,0	22 40,2	61,6	19
12	16 22,6	66,7	36 51,1	5,5	21 38,6	63,2	18
13	17 29,3	65,7	36 56,6	2,9	20 35,4	64,9	17
14	18 35,0	64,3	36 59,5	0,3	19 30,5	66,0	16
15	19 39,3	63,1	36 59,8	2,3	18 24,5	67,4	15
16	20 42,4	61,6	36 57,5	4,9	17 17,1	68,7	14
17	21 44,0	60,2	36 52,6	7,6	16 8,4	70,0	13
18	22 44,2	58,6	36 45,0	10,2	14 58,4	70,9	12
19	23 42,8	57,1	36 34,8	12,9	13 47,5	71,9	11
20	24 39,9	55,4	36 21,9	15,4	12 35,6	72,9	10
21	25 35,3	53,5	36 6,5	18,0	11 22,7	73,8	9
22	26 28,8	51,9	35 48,5	20,4	10 8,9	74,6	8
23	27 20,7	49,8	35 28,1	23,2	8 54,3	75,0	7
24	28 10,5	48,2	35 4,9	25,5	7 39,3	75,7	6
25	28 58,7	45,9	34 39,4	28,1	6 23,6	76,2	5
26	29 44,6	44,0	34 11,3	30,5	5 7,4	76,5	4
27	30 28,6	41,9	33 40,8	33,0	3 50,9	76,8	3
28	31 10,5	39,8	33 7,8	35,4	2 34,1	77,0	2
29	31 50,3	37,4	32 32,4	37,7	1 17,1	77,1	1
30	32 27,7		31 54,7		0 0,0		0
	+		+		+		
	8		7		6		S

XXI. For the ☽'s Lon.

Argument XXI.

2 Eq. Di. ☽ & ☌ — ☽'s C.A.

S	0 +	1 +	2 +	S
S	6 —	7 —	8 —	S
0	′ ″	′ ″	′ ″	0
00	0,0	0 42,1	1 12,9	30
1 0	1,5	0 43,3	1 13,6	29
2 0	2,9	0 44,6	1 14,3	28
3 0	4,4	0 45,9	1 14,9	27
4 0	5,9	0 47,0	1 15,6	26
5 0	7,3	0 48,2	1 16,2	25
6 0	8,8	0 49,4	1 16,8	24
7 0	10,3	0 50,6	1 17,4	23
8 0	11,7	0 51,8	1 18,0	22
9 0	13,2	0 53,0	1 18,5	21
10 0	14,6	0 54,1	1 19,0	20
11 0	16,1	0 55,2	1 19,5	19
12 0	17,5	0 56,3	1 20,0	18
13 0	18,9	0 57,4	1 20,4	17
14 0	20,4	0 58,4	1 20,8	16
15 0	21,8	0 59,5	1 21,2	15
16 0	23,2	1 0,5	1 21,6	14
17 0	24,6	1 1,5	1 22,0	13
18 0	26,0	1 2,5	1 22,3	12
19 0	27,4	1 3,5	1 22,6	11
20 0	28,8	1 4,4	1 22,9	10
21 0	30,1	1 5,4	1 23,1	9
22 0	31,5	1 6,3	1 23,3	8
23 0	32,9	1 7,2	1 23,5	7
24 0	34,2	1 8,1	1 23,7	6
25 0	35,5	1 8,9	1 23,8	5
26 0	36,9	1 9,7	1 23,9	4
27 0	38,2	1 10,5	1 24,0	3
28 0	39,5	1 11,3	1 24,1	2
29 0	40,8	1 12,1	1 24,1	1
30 0	42,1	1 12,8	1 24,1	0
	+	—	—	
S	11	10	9	
	—	+	+	
S	5	4	3	

XXII. For the ☽'s Long. Reduct.

Argument XXII.

Long. ☽ in Orbit. — Correct Long. ☌

S	0 —	Dif.	1 —	Dif.	2 —	Dif.	S
S	6 —		7 —		8 —		S
0	′ ″	″	′ ″	″	′ ″	″	0
0	0,0	14,2	5 53,1	6,9	5 53,1	7,3	30
0	14,2	14,2	6 0,0	6,4	5 45,8	7,8	29
0	28,4	14,2	6 6,4	6,0	5 38,0	8,2	28
0	42,6	14,1	6 12,4	5,6	5 29,8	8,5	27
0	56,7	14,1	6 18,0	5,1	5 21,3	9,0	26
1	10,8	14,0	6 23,1	4,7	5 12,3	9,3	25
1	24,8	13,8	6 27,8	4,1	5 3,0	9,7	24
1	38,6	13,8	6 31,9	3,7	4 53,3	10,1	23
1	52,4	13,6	6 35,6	3,2	4 43,2	10,4	22
2	6,0	13,4	6 38,8	2,7	4 32,8	10,7	21
2	19,4	13,3	6 41,5	2,2	4 22,1	11,1	20
2	32,7	13,1	6 43,7	1,8	4 11,0	11,4	19
2	45,8	12,9	6 45,5	1,2	3 59,6	11,6	18
2	58,7	12,7	6 46,7	0,7	3 48,0	11,9	17
3	11,4	12,5	6 47,4	0,3	3 36,1	12,2	16
3	23,9	12,2	6 47,7	0,3	3 23,9	12,5	15
3	36,1	11,9	6 47,4	0,7	3 11,4	12,7	14
3	48,0	11,6	6 46,7	1,2	2 58,7	12,9	13
3	59,6	11,4	6 45,5	1,8	2 45,8	13,1	12
4	11,0	11,1	6 43,7	2,2	2 32,7	13,3	11
4	22,1	10,7	6 41,5	2,7	2 19,4	13,4	10
4	32,8	10,4	6 38,8	3,2	2 6,0	13,6	9
4	43,2	10,1	6 35,6	3,7	1 52,4	13,8	8
4	53,3	9,7	6 31,9	4,1	1 38,6	13,8	7
5	3,0	9,3	6 27,8	4,7	1 24,8	14,0	6
5	12,3	9,0	6 23,1	5,1	1 10,8	14,1	5
5	21,3	8,5	6 18,0	5,6	0 56,7	14,1	4
5	29,8	8,2	6 12,4	6,0	0 42,6	14,2	3
5	38,0	7,8	6 6,4	6,4	0 28,4	14,2	2
5	45,8	7,3	6 0,0	6,9	0 14,2	14,2	1
5	53,1		5 53,1		0 0,0		0
	+		+		+		
S	11		10		9		S
	+		+		+		
S	5		4		3		S

Equation of the Equinoctial Point.

Argument. Mean Longitude Moon's Node.

S	0 —	1 —	2 —	S
S	6 +	7 +	8 +	S
0	″	″	″	0
00,0	9,0	15,6		30
1 0,3	9,3	15,8		29
2 0,6	9,5	15,9		28
3 0,9	9,8	16,0		27
4 1,2	10,0	16,2		26
5 1,5	10,3	16,3		25
6 1,9	10,6	16,4		24
7 2,2	10,8	16,6		23
8 2,5	11,1	16,7		22
9 2,8	11,3	16,8		21
10 3,1	11,6	16,9		20
11 3,4	11,8	17,0		19
12 3,7	12,0	17,1		18
13 4,0	12,3	17,2		17
14 4,4	12,5	17,3		16
15 4,7	12,7	17,4		15
16 5,0	13,0	17,5		14
17 5,3	13,2	17,5		13
18 5,6	13,4	17,6		12
19 5,9	13,6	17,7		11
20 6,1	13,8	17,7		10
21 6,4	14,0	17,8		9
22 6,7	14,2	17,8		8
23 7,0	14,4	17,9		7
24 7,3	14,6	17,9		6
25 7,6	14,7	17,9		5
26 7,9	14,9	18,0		4
27 8,2	15,1	18,0		3
28 8,4	15,3	18,0		2
29 8,7	15,4	18,0		1
30 9,0	15,6	18,0		0
	+	+	+	
S	11	10	9	
	—	—	—	
S	5	4	3	

I. For the MOON's Latitude.

Argument I. Long. ☽ in Orbit — Correct Long. ☊

S	0 + 6 —	Diff.	1 + 7 —	Diff.	2 + 8 —	Diff.	S
0	° ′ ″	′ ″	° ′ ″	′ ″	° ′ ″	′	8
0	0 0,0	5 23,0	2 34 17,9	4 38,6	4 27 22,6	2 39,4	30
1	0 5 23,0	5 23,0	2 38 56,5	4 35,7	4 30 2,0	2 34,6	29
2	0 10 46,0	5 22,7	2 43 32,2	4 32,8	4 32 36,6	2 29,6	28
3	0 16 8,7	5 22,5	2 48 5,0	4 29,6	4 35 6,2	2 24,5	27
4	0 21 31,2	5 22,2	2 52 34,6	4 26,4	4 37 30,7	2 19,4	26
5	0 26 53,4	5 21,6	2 57 1,0	4 23,4	4 39 50,1	2 14,3	25
6	0 32 15,0	5 20,9	3 1 24,4	4 19,9	4 42 4,4	2 9,2	24
7	0 37 35,9	5 20,4	3 5 44,3	4 16,6	4 44 13,6	2 3,9	23
8	0 42 56,3	5 19,6	3 10 0,9	4 13,0	4 46 17,5	1 58,6	22
9	0 48 15,9	5 18,7	3 14 13,9	4 9,6	4 48 16,1	1 53,4	21
10	0 53 34,6	5 17,7	3 18 23,5	4 6,0	4 50 9,5	1 48,1	20
11	0 58 52,3	5 16,6	3 22 29,5	4 2,2	4 51 57,6	1 42,8	19
12	1 4 8,9	5 15,5	3 26 31,7	3 58,5	4 53 40,4	1 37,5	18
13	1 9 24,4	5 14,2	3 30 30,2	3 54,6	4 55 17,9	1 31,9	17
14	1 14 38,6	5 12,8	3 34 24,8	3 50,8	4 56 49,8	1 26,6	16
15	1 19 51,4	5 11,3	3 38 15,6	3 46,9	4 58 16,4	1 21,2	15
16	1 25 2,7	5 9,6	3 42 2,5	3 42,7	4 59 37,6	1 15,6	14
17	1 30 12,6	5 8,3	3 45 45,2	3 38,6	5 0 53,2	1 10,1	13

S	0 + 6 —	Diff.	1 + 7 —	Diff.	2 + 8 —	Diff.	S
0	° ′ ″	′ ″	° ′ ″	′ ″	° ′ ″	′	8
18	1 35 20,9	5 6,4	3 49 23,8	3 34,4	5 2 3,3	1 4,6	12
19	1 40 27,3	5 4,7	3 52 58,2	3 30,2	5 3 7,9	0 59,0	11
20	1 45 32,0	5 2,8	3 56 28,4	3 25,8	5 4 6,9	0 53,5	10
21	1 50 34,0	5 0,7	3 59 54,2	3 21,5	5 5 0,4	0 47,9	9
22	1 55 35,5	4 58,6	4 3 15,7	3 17,0	5 5 48,3	0 42,3	8
23	2 0 34,1	4 56,4	4 6 32,7	3 12,5	5 6 30,6	0 36,6	7
24	2 5 30,5	4 54,1	4 9 45,2	3 8,1	5 7 7,2	0 31,0	6
25	2 10 24,6	4 51,8	4 12 53,3	3 3,3	5 7 38,2	0 25,5	5
26	2 15 16,4	4 49,3	4 15 56,6	2 58,7	5 8 3,7	0 19,8	4
27	2 20 5,7	4 46,7	4 18 55,3	2 53,9	5 8 23,5	0 14,2	3
28	2 24 52,4	4 44,0	4 21 49,2	2 49,1	5 8 37,7	0 8,4	2
29	2 29 36,4	4 41,5	4 24 38,3	2 44,3	5 8 46,1	0 2,8	1
30	2 34 17,9		4 27 22,6		5 8 48,9		0
	—		—		—		
S	11		10		9		S
	+		+		+		
S	5		4		3		S

II. For the Moon's Latitude.

Arg. II. Do. Dist. ☽ in Orb. a ☉ — Ar. I.

S	0 +		1 +		2 +	
S	6 —	Dif.	7 —	Dif.	8 —	Dif.
○	′ ″	″	′ ″	″	′ ″	″
0	0 0,0	9,2	4 24,2	7,9	7 37,6	4,5
1	0 9,2	9,3	4 32,1	7,9	7 42,1	4,4
2	0 18,5	9,2	4 40,0	7,8	7 46,5	4,3
3	0 27,7	9,2	4 47,8	7,6	7 50,8	4,1
4	0 36,9	9,2	4 55,4	7,7	7 54,9	4,0
5	0 46,1	9,2	5 3,1	7,5	7 58,9	3,8
6	0 55,3	9,1	5 10,6	7,4	8 2,7	3,7
7	1 4,4	9,2	5 18,0	7,3	8 6,4	3,5
8	1 13,6	9,1	5 25,3	7,2	8 9,9	3,4
9	1 22,7	9,0	5 32,5	7,2	8 13,3	3,2
10	1 31,7	9,1	5 39,7	7,0	8 16,5	3,
11	1 40,8	9,0	5 46,7	6,9	8 19,6	2,9
12	1 49,8	9,1	5 53,6	6,8	8 22,5	2,8
13	1 58,9	8,9	6 0,4	6,7	8 25,3	2,6
14	2 7,8	8,9	6 7,1	6,6	8 27,9	2,5
15	2 16,7	8,9	6 13,7	6,4	8 30,4	2,3
16	2 25,6	8,9	6 20,1	6,4	8 32,7	2,2
17	2 34,5	8,8	6 26,5	6,2	8 34,9	2,0
18	2 43,3	8,7	6 32,7	6,1	8 36,9	1,8
19	2 52,0	8,7	6 38,8	6,0	8 38,7	1,7
20	3 0,7	8,7	6 44,8	5,9	8 40,4	1,5
21	3 9,4	8,6	6 50,7	5,7	8 41,9	1,4
22	3 18,0	8,5	6 56,4	5,6	8 43,3	1,2
23	3 26,5	8,4	7 2,0	5,5	8 44,5	1,0
24	3 34,9	8,4	7 7,5	5,3	8 45,5	0,9
25	3 43,3	8,4	7 12,8	5,2	8 46,4	0,7
26	3 51,7	8,2	7 18,0	5,1	8 47,1	0,6
27	3 59,9	8,2	7 23,1	5,0	8 47,7	0,4
28	4 8,1	8,1	7 28,1	4,8	8 48,1	0,2
29	4 16,2	8,0	7 32,9	4,7	8 48,3	0,1
30	4 24,2		7 37,6		8 48,4	
S	— 11		— 10		— 9	
S	+ 5		+ 4		+ 3	

For the ☽'s Lat.

Argument III.

Arg. I. — ☉'s M.A.

○ +	1 +	2 +	S
6 —	7 —	8 —	S
′	′	″	○
0,0	1,6	2,7	30
0,1	1,6	2,7	29
0,2	1,6	2,7	28
0,2	1,7	2,8	27
0,3	1,7	2,8	26
0,3	1,8	2,8	25
0,4	1,8	2,9	24
0,4	1,9	2,9	23
0,5	1,9	2,9	22
0,5	2,0	2,9	21
0,6	2,0	2,9	20
0,7	2,0	2,9	19
0,7	2,1	3,0	18
0,8	2,1	3,0	17
0,8	2,2	3,0	16
0,9	2,2	3,0	15
0,9	2,2	3,0	14
0,9	2,3	3,0	13
1,0	2,3	3,0	12
1,0	2,3	3,0	11
1,1	2,4	3,1	10
1,1	2,4	3,1	9
1,2	2,4	3,1	8
1,2	2,5	3,1	7
1,	2,5	3,1	6
1,	2,5	3,1	5
1,4	2,6	3,1	4
1,	2,6	3,1	3
1,5	2,6	3,1	2
1,5	2,	3,1	1
1,6	2,7	3,1	0
— 11	10	9	S
+ 5	4	2	S

IV. For ☽'s Lat.

Argument IV.

Ar. I. — ☽'s M. A.

S	0 —	1 —	2 —	0 —	1 —	2 —	S
S	6 +	7 +	8 +	6 +	7 +	8 +	S
0	″	″	″	″	″	″	0
0	5,4	13,1	17,2	7,7	18,7	24,6	30
1	5,7	13,3	17,2	8,2	18,9	24,6	29
2	6,0	13,5	17,3	8,6	19,2	24,7	28
3	6,3	13,7	17,3	9,0	19,5	24,8	27
4	6,6	13,9	17,4	9,4	19,8	24,9	26
5	6,9	14,1	17,4	9,8	20,0	24,9	25
6	7,2	14,2	17,5	10,2	20,3	25,0	24
7	7,5	14,4	17,5	10,6	20,6	25,0	23
8	7,7	14,6	17,6	11,0	20,8	25,0	22
9	8,0	14,7	17,6	11,4	21,1	25,1	21
10	8,3	14,9	17,6	11,8	21,3	25,1	20
11	8,5	15,0	17,6	12,2	21,5	25,1	19
12	8,8	15,2	17,6	12,6	21,7	25,1	18
S	+ 11	+ 10	+ 9	+ 11	+ 10	+ 9	S
S	— 5	— 4	— 3	— 5	— 4	— 3	S

V. For ☽'s Lat.

Arg. V.

A. IV. — ☽ M.A.

0 +	1 +	2 +	S
6 —	7 —	8 —	S
″	″	″	○
0,6	1,4	1,9	30
0,6	1,4	1,9	29
0,7	1,5	1,9	28
0,7	1,5	1,9	27
0,7	1,5	1,9	26
0,7	1,5	1,9	25
0,8	1,5	1,9	24
0,8	1,6	1,9	23
0,8	1,6	1,9	22
0,9	1,6	1,9	21
0,9	1,6	1,9	20
0,9	1,6	1,9	19
1,0	1,7	1,9	18
— 11	10	9	S
+ 5	4	3	S

VI. For ☽ La.

Arg. VI.

A.V. — ☽ M.A.

0 +	1 +	2 +	S
6 —	7 —	8 —	S
″	″	″	○
2,8	6,7	8,8	30
2,9	6,8	8,8	29
3,1	6,9	8,9	28
3,2	7,0	8,9	27
3,4	7,1	8,9	26
3,5	7,2	8,9	25
3,7	7,3	9,0	24
3,8	7,4	9,0	23
4,0	7,5	9,0	22
4,1	7,5	9,0	21
4,2	7,6	9,0	20
4,4	7,7	9,0	19
4,5	7,8	9,0	18
— 11	10	9	S
+ 5	4	3	S

VII. For ☽'s La.

Argument VII.

Ar. II. + ☉'s M.A.

0 +	1 +	2 +	S
6 +	7 +	8 +	S
″	″	″	0
0,0	1,9	3,2	30
0,1	1,9	3,2	29
0,1	2,0	3,3	28
0,2	2,0	3,3	27
0,3	2,1	3,3	26
0,3	2,1	3,4	25
0,4	2,2	3,4	24
0,5	2,2	3,4	23
0,5	2,3	3,4	22
0,6	2,3	3,5	21
0,6	2,4	3,5	20
0,7	2,4	3,5	19
0,8	2,5	3,5	18
0,8	2,5	3,5	17
0,9	2,6	3,6	16
1,0	2,6	3,6	15
1,0	2,7	3,6	14
1,1	2,7	3,6	13
1,1	2,8	3,6	12
1,2	2,8	3,6	11
1,3	2,8	3,6	10
1,3	2,9	3,7	9
1,4	2,9	3,7	8
1,4	3,0	3,7	7
1,5	3,0	3,7	6
1,6	3,0	3,7	5
1,6	3,1	3,7	4
1,7	3,1	3,7	3
1,7	3,1	3,7	2
1,8	3,2	3,7	1
1,9	3,2	3,7	0
— 11	10	9	S
+ 5	4	3	S

VIII. For ☽ Lat.

Arg. VIII.

Arg. II. — ☉ M. A.

S	0 —	1 —		S
S	6 +	7 +	8 +	S
0	″	″		0
0	0,0	1,9	3,2	30
1	0,1	1,9	3,2	29
2	0,1	2,0	3,3	28
3	0,2	2,0	3,3	27
4	0,3	2,1	3,3	26
5	0,3	2,1	3,4	25
6	0,4	2,2	3,4	24
7	0,5	2,2	3,4	23
8	0,5	2,3	3,4	22
9	0,6	2,3	3,5	21
10	0,6	2,4	3,5	20
11	0,7	2,4	3,5	19
12	0,8	2,5	3,5	18
13	0,8	2,5	3,5	17
14	0,9	2,6	3,6	16
15	1,0	2,6	3,6	15
16	1,0	2,7	3,6	14
17	1,1	2,7	3,6	13
18	1,1	2,8	3,6	12
19	1,2	2,8	3,6	11
20	1,3	2,8	3,6	10
21	1,3	2,9	3,7	9
22	1,4	2,9	3,7	8
23	1,4	3,0	3,7	7
24	1,5	3,0	3,7	6
25	1,6	3,0	3,7	5
26	1,6	3,1	3,7	4
27	1,7	3,1	3,7	3
28	1,7	3,1	3,7	2
29	1,8	3,2	3,7	1
30	1,9	3,2	3,7	0
S	+ 11	+ 10	+ 9	S
S	— 5	— 4	— 3	S

IX. For ☽'s Lat.

Arg. IX.

Ar. II. + ☽ M.A.

0 +	1 +	2 +	S
6 —	7 —	8 —	S
″	″	″	○
0,0	1,1	1,9	30
0,0	1,1	1,9	29
0,1	1,2	1,9	28
0,2	1,2	2,0	27
0,2	1,2	2,0	26
0,3	1,3	2,0	25
0,3	1,3	2,0	24
0,4	1,3	2,0	23
0,4	1,4	2,0	22
0,5	1,4	2,0	21
0,5	1,4	2,0	20
0,6	1,4	2,1	19
0,6	1,5	2,1	18
0,6	1,5	2,1	17
0,7	1,5	2,1	16
0,7	1,5	2,1	15
0,7	1,6	2,1	14
0,8	1,6	2,2	13
0,8	1,6	2,2	12
0,8	1,6	2,2	11
0,9	1,7	2,2	10
0,9	1,7	2,2	9
0,9	1,7	2,2	8
1,0	1,8	2,2	7
1,0	1,8	2,2	6
1,0	1,8	2,2	5
1,0	1,8	2,2	4
1,0	1,9	2,2	3
1,0	1,9	2,2	2
1,1	1,9	2,2	1
1,1	1,9	2,2	0
S + 11	+ 10	+ 9	S
S — 5	— 4	— 3	S

X. For ☽'s Lat.

Arg. X.

Ar. II. — ☽ M.A.

0 +	1 +	2 +	S
6 —	7 —	8 —	S
″	″	″	○
0,0	8,0	13,8	30
0,1	8,2	13,9	29
0,1	8,4	14,0	28
0,2	8,6	14,2	27
0,3	8,8	14,3	26
0,4	9,0	14,4	25
0,5	9,1	14,4	24
0,5	9,3	14,5	23
0,6	9,5	14,6	22
0,7	9,7	14,7	21
0,8	9,9	14,8	20
0,9	10,1	14,9	19
1,0	10,3	15,0	18
1,1	10,6	15,1	17
1,2	10,8	15,2	16
1,3	11,0	15,3	15
1,4	11,2	15,4	14
1,4	11,4	15,4	13
1,5	11,6	15,5	12
1,6	11,8	15,6	11
1,7	12,0	15,6	10
1,8	12,2	15,7	9
1,9	12,4	15,7	8
2,0	12,5	15,7	7
2,0	12,7	15,8	6
2,1	12,9	15,8	5
2,2	13,0	15,8	4
2,3	13,2	15,9	3
2,4	13,3	15,9	2
2,4	13,4	15,9	1
2,5	13,6	15,9	0
S + 11	+ 10	+ 9	S
S — 5	— 4	— 3	S

XI. For ☽'s Lat.

Argument XI.

Ar. X. — ☽'s M.A.

0 —	1 —	2 —	S
6 +	7 +	8 +	S
″	″	″	○
0,0	2,6	4,5	30
0,1	2,7	4,5	29
0,2	2,7	4,6	28
0,3	2,8	4,6	27
0,4	2,9	4,7	26
0,5	3,0	4,7	25
0,5	3,0	4,7	24
0,6	3,1	4,8	23
0,7	3,2	4,8	22
0,8	3,3	4,8	21
0,9	3,4	4,9	20
1,0	3,4	4,9	19
1,1	3,5	4,9	18
1,2	3,6	5,0	17
1,3	3,6	5,0	16
1,4	3,7	5,0	15
1,4	3,7	5,0	14
1,5	3,8	5,1	13
1,6	3,9	5,1	12
1,7	3,9	5,1	11
1,8	4,0	5,1	10
1,9	4,0	5,1	9
2,0	4,1	5,1	8
2,0	4,2	5,2	7
2,1	4,2	5,2	6
2,2	4,3	5,2	5
2,3	4,3	5,2	4
2,4	4,4	5,2	3
2,4	4,4	5,2	2
2,5	4,5	5,2	1
2,6	4,5	5,2	0
S — 11	— 10	— 9	S
S + 5	+ 4	+ 3	S

I. For the Equatorial Parallax of the Moon.

Argument I.
Argument of Longitude I.
☉'s Mean Anomaly.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	I	0
0	0,3	0,2	0,2	30
5	0,3	0,2	0,1	25
10	0,3	0,2	0,1	20
15	0,3	0,2	0,1	15
20	0,3	0,2	0,1	10
25	0,3	0,2	0,0	5
30	0,3	0,2	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

II. For the Equatorial Parallax of the Moon.

Argument II.
Argument of Longitude II.
2☽ à ☉ + ☽'s Mean Anomaly.

S	0	1	2	S
	—	—	—	
S	6	7	8	S
	+	+	+	
0	//	//	I	0
0	0,7	0,6	0,4	30
5	0,7	0,6	0,3	25
10	0,7	0,5	0,3	20
15	0,7	0,5	0,2	15
20	0,7	0,5	0,2	10
25	0,6	0,4	0,1	5
30	0,6	0,4	0,0	0
	—	—	—	
S	11	10	9	S
	+	+	+	
S	5	4	3	S

III. For the Equatorial Parallax of the Moon.

Argument III.
Argument of Longitude III.
2☽ á ☉ — ☽'s M. Anomaly.

S	0	1	2	S
	—	—	—	
S	6	7	8	S
	+	+	+	
0	//	//	//	//
0	0,8	0,7	0,4	30
5	0,8	0,7	0,3	25
10	0,8	0,6	0,3	20
15	0,8	0,6	0,2	15
20	0,8	0,5	0,2	10
25	0,7	0,5	0,1	5
30	0,7	0,4	0,0	0
	—	—	—	S
S	11	10	9	
	+	+	+	
S	5	4	3	S

IV. For the Equatorial Parallax of the Moon.

Argument IV.
Argument of Longitude IV.
2☽ à ☉ + ☽'s Mean Anomaly.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	//	0
0	0,1	0,1	0,0	30
5	0,1	0,1	0,0	25
10	0,1	0,1	0,0	20
15	0,1	0,1	0,0	15
20	0,1	0,1	0,0	10
25	0,1	0,0	0,0	5
30	0,1	0,0	0,0	0
S	+	+	+	
	11	10	9	S
	—	—	—	
	5	4	3	S

V. For the Equatorial Parallax of the Moon.

Argument V.
Argument of Longitude V.
2☽ à ☉ — ☽'s Mean Anomaly.

S	0	1	2	3	4	5	S
	—	—	—	∓	+	+	
0	//	//	//	//	//	//	0
0	37,0	32,1	18,8	0,3	18,5	32,5	30
1	37,0	31,8	18,2	0,3	19,1	32,8	29
2	37,0	31,4	17,7	1,0	19,6	33,1	28
3	37,0	31,1	17,1	1,6	20,2	33,4	27
4	36,9	30,7	16,6	2,3	20,7	33,7	26
5	36,9	30,4	16,0	2,9	21,3	34,0	25
6	36,8	30,0	15,4	3,6	21,8	34,3	24
7	36,7	29,7	15,8	4,2	22,4	34,5	23
8	36,6	29,3	14,2	4,9	22,9	34,8	22
9	36,5	28,9	13,6	5,5	23,4	35,0	21
10	36,4	28,5	13,0	6,2	23,9	35,3	20
11	36,3	28,1	12,4	6,8	24,4	35,5	19
12	36,2	27,7	11,8	7,5	24,9	35,7	18
13	36,0	27,3	11,2	8,1	25,4	35,9	17
14	35,9	26,9	10,6	8,8	25,9	36,1	16
15	35,7	26,4	10,0	9,4	26,4	36,3	15

V. For the Equatorial Parallax of the Moon.

Argument V.
Argument of Longitude V.
2☽ à ☉ — ☽'s Mean Anomaly.

S	0	1	2	3	4	5	S
	—	—	—	+	+	+	
0	//	//	//	//	//	//	0
16	35,6	26,0	9,4	10,0	26,9	36,4	14
17	35,4	25,5	8,7	10,7	27,3	36,6	13
18	35,2	25,1	8,1	11,3	27,8	36,7	12
19	35,0	24,6	7,4	11,9	28,3	36,9	11
20	34,8	24,1	6,8	12,6	28,7	37,0	10
21	34,6	23,6	6,1	13,2	29,1	37,1	9
22	34,4	23,1	5,5	13,8	29,5	37,2	8
23	34,1	22,5	4,8	14,4	29,9	37,3	7
24	33,9	22,0	4,2	15,0	30,3	37,4	6
25	33,6	21,5	3,5	15,6	30,7	37,5	5
26	33,3	21,0	2,9	16,2	31,1	37,5	4
27	33,0	20,4	2,2	16,8	31,4	37,6	3
28	32,7	19,9	1,6	17,4	31,8	37,6	2
29	32,4	19,3	0,9	18,0	32,1	37,6	1
30	32,1	18,8	0,3	18,5	32,5	37,6	0
	—	—	—	∓	+	+	
S	11	10	9	8	7	6	S

VI. For Equato. par. ☽

Argument VI.
Argument of Long. VI.
Arg. V. + Arg. I.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	//	0
0	1,0	0,9	0,5	30
5	1,0	0,8	0,4	25
10	1,0	0,8	0,3	20
15	1,0	0,7	0,3	15
20	0,9	0,6	0,2	10
25	0,9	0,6	0,1	5
30	0,9	0,5	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

VII. For Equat. paral. ☽

Argument VII.
Argument of Long. VII.
Arg. V. — Arg. I.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	//	0
0	0,6	0,5	0,3	30
5	0,6	0,5	0,3	25
10	0,6	0,4	0,2	20
15	0,6	0,4	0,2	15
20	0,6	0,4	0,1	10
25	0,5	0,3	0,1	5
30	0,5	0,3	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

VIII. For Equa. paral. ☽

Argument VIII.
Argument of Lon. VIII.
☽'s M. An. — ☉'s M.A

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	//	0
0	0,2	0,2	0,1	30
5	0,2	0,2	0,1	25
10	0,2	0,2	0,1	20
15	0,2	0,1	0,1	15
20	0,2	0,1	0,0	10
25	0,2	0,1	0,0	5
30	0,2	0,1	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

IX. For the Equatorial Parallax of the Moon.

Argument IX.
Argument of Longitude IX.
M. Dist. ☽ à ☉ — ☽'s M. An.

S	0	1	2	3	4	5	S
	+	±	—	—	∓	+	
0	//	//	//	I	//	//	0
0	0,4	0,2	0,2	0,4	0,2	0,2	30
5	0,4	0,1	0,2	0,4	0,1	0,2	25
10	0,4	0,1	0,3	0,4	0,1	0,3	20
15	0,3	0,0	0,3	0,3	0,0	0,3	15
20	0,3	0,1	0,4	0,3	0,1	0,4	10
25	0,2	0,1	0,4	0,2	0,1	0,4	5
30	0,2	0,2	0,4	0,2	0,2	0,4	0
	+	+	—	—	∓	+	
S	11	10	9	8	7	6	S

X. For the Equatorial Parallax of the Moon.

Argument X.
Argument of Longitude X.
M. Long. ☊ — True Long. ☉

S	0	1	2	3	4	5	S
	+	±	—	—	∓	+	
0	//	//	//	//	//	//	0
0	2,2	1,2	0,9	2,0	1,1	0,8	30
5	2,1	0,9	1,2	2,0	0,8	1,1	25
10	2,0	0,5	1,4	1,9	0,5	1,3	20
15	1,9	0,1	1,6	1,8	0,1	1,5	15
20	1,7	0,2	1,8	1,6	0,2	1,6	10
25	1,5	0,6	1,9	1,4	0,5	1,7	5
30	1,2	0,9	2,0	1,1	0,8	1,8	0
	+	±	—	—	∓	+	
S	11	10	9	8	7	6	S

XI. For the Equatorial Parallax of the Moon.

Argument XI.
Argument of Longitude XI.
☽'s Correct Anomaly.

S	0		1		2		3		4		5		S
	+	Dif.	+	Dif.	+	Dif.	+	Dif.	+	Dif.	+	Dif.	
0	° ′	″	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″	0
0	54 13,0	0,0	54 33,5	1,4	55 32,5	2,6	57 1,0	3,3	58 39,5	3,1	59 58,6	1,9	30
1	44 13,0	0,1	54 34,9	1,4	55 35,1	2,6	57 4,3	3,3	58 42,6	3,1	60 0,5	1,8	29
2	54 13,1	0,1	54 36,3	1,5	55 37,7	2,6	57 7,6	3,3	58 45,7	3,1	60 2,3	1,8	28
3	54 13,2	0,2	54 37,8	1,4	55 40,3	2,6	57 10,9	3,3	58 48,8	3,1	60 4,1	1,8	27
4	54 13,4	0,2	54 39,2	1,5	55 42,9	2,7	57 14,2	3,3	58 51,9	3,0	60 5,9	1,7	26
5	54 13,6	0,3	54 40,7	1,6	55 45,6	2,7	57 17,5	3,4	58 54,9	3,0	60 7,6	1,6	25
6	54 13,9	0,3	54 42,3	1,6	55 48,3	2,7	57 20,9	3,3	58 57,9	3,0	60 9,2	1,6	24
7	54 14,2	0,4	54 43,9	1,7	55 51,0	2,8	57 24,2	3,3	59 0,9	3,0	60 10,8	1,5	23
8	54 14,6	0,4	54 45,6	1,7	55 53,8	2,8	57 27,5	3,3	59 3,9	2,9	60 12,3	1,5	22
9	54 15,0	0,4	54 47,3	1,8	55 56,6	2,8	57 30,8	3,3	59 6,8	2,9	60 13,8	1,4	21
10	54 15,4	0,5	54 49,1	1,8	55 59,4	2,8	57 34,1	3,3	59 9,7	2,9	60 15,2	1,3	20
11	54 15,9	0,6	54 50,9	1,8	56 2,2	2,9	57 37,5	3,4	59 12,6	2,9	60 16,5	1,3	19
12	54 16,5	0,5	54 52,7	1,8	56 5,1	2,9	57 40,8	3,3	59 15,4	2,8	60 17,8	1,2	18
13	54 17,0	0,6	54 54,5	1,9	56 8,0	2,9	57 44,1	3,3	59 18,2	2,8	60 19,0	1,1	17
14	54 17,6	0,6	54 56,4	1,9	56 10,9	2,9	57 47,4	3,3	59 20,9	2,7	60 21,1	1,1	16
15	54 18,2	0,7	54 58,3	2,0	56 13,9	3,0	57 50,7	3,3	59 23,6	2,7	60 21,2	1,0	15
16	54 18,9	0,7	55 0,3	2,1	56 16,9	3,0	57 54,0	3,3	59 26,2	2,6	60 22,2	0,9	14
17	54 19,6	0,8	55 2,4	2,1	56 19,9	3,1	57 57,3	3,3	59 28,8	2,6	60 23,1	0,9	13
18	54 20,4	0,8	55 4,5	2,2	56 23,0	3,1	58 0,6	3,3	59 31,4	2,5	60 24,0	0,8	12
19	54 21,2	0,9	55 6,7	2,2	56 26,1	3,1	58 3,9	3,3	59 33,9	2,5	60 24,8	0,7	11
20	54 22,1	0,9	55 8,9	2,2	56 29,2	3,1	58 7,2	3,3	59 36,4	2,4	60 25,5	0,6	10
21	54 23,0	1,0	55 11,1	2,3	56 32,3	3,1	58 10,5	3,3	59 38,8	2,4	60 26,1	0,6	9
22	54 24,0	1,0	55 13,4	2,3	56 35,4	3,1	58 13,8	3,2	59 41,2	2,3	60 26,7	0,5	8
23	54 25,0	1,1	55 15,7	2,3	56 38,5	3,2	58 17,0	3,3	59 43,5	2,3	60 27,2	0,5	7
24	54 26,1	1,1	55 18,0	2,3	56 41,7	3,2	58 20,3	3,3	59 45,8	2,3	60 27,7	0,4	6
25	54 27,2	1,2	55 20,3	2,4	56 44,9	3,2	58 23,6	3,2	59 48,1	2,2	60 28,1	0,3	5
26	54 28,4	1,2	55 22,7	2,4	56 48,1	3,2	58 26,8	3,2	59 50,3	2,1	60 28,4	0,3	4
27	54 29,6	1,3	55 25,1	2,4	56 51,3	3,2	58 30,0	3,2	59 52,4	2,1	60 28,7	0,2	3
28	54 30,9	1,3	55 27,5	2,4	56 54,5	3,2	58 33,2	3,2	59 54,5	2,1	60 28,9	0,1	2
29	54 32,2	1,3	55 30,0	2,5	56 57,7	3,3	58 36,4	3,1	59 56,6	2,0	60 29,0	0,0	1
30	54 32,5		55 32,5		57 1,0		58 39,5		59 58,6		60 29,0		0
	+		+		+		+		+		+		
S	11		10		9		8		7		6		S

XII. For Equat. Par. of the ☽

Argument XII.
Argument of Longitude XII.
☽'s Eq. Long.— ☉'s Tr. Lon.

0	1	2	3	4	5	S
+	±	—	—	∓	+	
″	″	″	″	″	″	0
25,2	12,0	13,6	25,8	12,6	13,8	30
25,2	11,2	14,3	25,8	11,8	14,6	29
25,1	10,4	15,1	25,7	11,0	15,4	28
25,0	9,6	15,8	25,6	10,2	16,2	27
24,9	8,8	16,5	25,5	9,4	16,9	26
24,8	7,9	17,2	25,3	8,5	17,6	25
24,6	7,1	17,9	25,1	7,7	18,3	24
24,4	6,2	18,5	24,9	6,8	19,0	23
24,2	5,3	19,1	24,7	5,9	19,6	22
23,9	4,4	19,7	24,4	5,0	20,2	21
23,6	3,5	20,3	24,1	4,1	20,8	20
23,3	2,7	20,8	23,8	3,2	21,4	19
22,9	1,8	21,3	23,4	2,3	22,0	18
22,5	0,9	21,8	23,0	1,4	22,6	17
22,1	0,0	22,3	22,6	0,5	23,1	16
21,7	0,9	22,7	22,1	0,5	23,6	15
21,2	1,7	23,1	21,6	1,4	24,0	14
20,7	2,6	23,5	21,1	2,4	24,4	13
20,2	3,5	23,9	20,6	3,3	24,8	12
19,6	4,4	24,2	20,1	4,2	25,2	11
19,0	5,3	24,5	19,5	5,1	25,5	10
18,4	6,1	24,8	18,9	6,0	25,8	9
17,8	7,0	25,0	18,3	6,9	26,1	8
17,2	7,8	25,2	17,6	7,8	26,4	7
16,5	8,7	25,4	16,9	8,7	26,6	6
15,8	9,6	25,5	16,2	9,6	26,8	5
15,1	10,4	25,6	15,5	10,5	26,9	4
14,4	11,2	25,7	14,8	11,3	27,0	3
13,6	12,0	25,7	14,1	12,2	27,1	2
12,8	12,8	25,8	13,4	13,0	27,2	1
12,0	13,6	25 8	12,6	13,8	27,2	0
+	±	—	—	∓	+	
11	10	9	8	7	6	S

XIII. For the Equatorial Parallax of the Moon.

Argument XIII.
Argument of Longitude XIII
D. Eq. dist. ☽ ☌ ☊ — ☽ Cor. A.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
°	″	″	″	″
0	0,8	0,7	0,4	30
5	0,8	0,7	0,3	25
10	0,8	0,7	0 3	20
15	0,8	0,6	0 2	15
20	0,8	0,6	0,2	10
25	0,7	0,5	0,1	5
30	0,7	0 4	0 0	0
	+	+	+	S
S	11	10	9	
	—	—	—	
S	5	4	3	S

For finding the Horizontal Parallax by the Equatorial Parallax.

Also for the Reduction of the Elevation of the Pole.
Argument.
Elev. of the Pole in lat. & below Eq. Par.

Elev. Pole.	Reduction of Paral. 54′	57′	60′	Red. of Ele. of the Pole.	
	—	—	—	—	
°	″	″	″	′	″
0	0,0	0,0	0,0	0	0
6	0,2	0,2	0,2	3	6
12	0,6	0,7	0,7	6	4
18	1,4	1,4	1,5	8	57
24	2,3	2,5	2,6	11	6
30	3,5	3,7	3,9	12	56
36	4,9	5,1	5,4	14	12
42	6,3	6,7	7,0	14	51
48	7,7	8,2	8,6	14	51
54	9,2	9,7	10,2	14	12
60	10,5	11,1	11,7	12	56
66	11,7	12,4	13,0	11	6
72	12,7	13,4	14,1	8	57
78	13,4	14,2	14,9	6	4
84	13,9	14,6	15,4	3	6
90	14,1	14,8	15,6	0	0

For finding the Diameter of the Moon by the Equa. Paral.

Arg. Equa Paral. ☽				Arg. Equa Paral. ☽			
Eq. Par		Dia. ☽		Eq. Par		Dia. ☽	
° ′	″	′	″	° ′	″	′	″
54 0		29	25,8	58 0		31	36,6
54 10		29	31,2	58 10		31	42,0
54 20		29	36,7	58 20		31	47,5
54 30		29	42,1	58 30		31	52,9
54 40		29	47,6	58 40		31	58,4
54 50		29	53,0	58 50		32	3,8
55 0		29	58,5	59 0		32	9,3
55 10		30	3,9	59 10		32	14,7
55 20		30	9,4	59 20		32	20,2
55 30		30	14,8	39 30		32	25,6
55 40		30	20,3	59 40		32	31,1
55 50		30	25,7	59 50		32	36,5
56 0		30	31,2	60 0		32	42,0
56 10		30	36,6	60 10		32	47,4
56 20		30	42,1	60 20		32	52,9
56 30		30	47,5	60 30		32	58,3
56 40		30	53,0	60 40		33	3,8
56 50		30	58,4	60 50		33	9,2
57 0		31	3,9	61 0		33	14,7
57 10		31	9,3	61 10		33	20,1
57 20		31	14,8	61 20		33	25,6
57 30		31	20,2	61 30		33	31,0
57 40		31	25,7	61 40		33	36,5
57 50		31	31,1	61 50		33	41,9
58 0		31	36,6	62 0		33	47,3

I. For the Horary Motion of the Moon 's Long.

Argument I.
Argument of Longitude I.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//		0
0	0,5	0,4	0,2	30
5	0,5	0,4	0,2	25
10	0,5	0,4	0,2	20
15	0,5	0,3	0,1	15
20	0,4	0,3	0,1	10
25	0,4	0,3	0,0	5
30	0,4	0,2	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

II. For the Horary Motion of the Moon's Long.

Argument II.
Argument of Longitude II.

S	0	1	2	S
	—	—	—	
S	6	7	8	S
	+	+	+	
0	//	//	/	0
0	1,0	0,9	0,5	30
5	1,0	0,8	0,4	25
10	1,0	0,8	0,3	20
15	1,0	0,7	0,3	15
20	0,9	0,6	0,2	10
25	0,9	0,6	0,1	5
30	0,9	0,5	0,0	0
	—	—	—	
S	11	10	9	S
	+	+	+	
S	5	4	3	S

III. For the Horary Motion of the Moon's Long.

Argument III.
Argument of Longitude III.

S	0	1	2	S
	—	—	—	
S	6	7	8	S
	+	+	+	
0	''	//	//	0
0	1,2	1,0	0,6	30
5	1,2	1,0	0,5	25
10	1,2	0,9	0,4	20
15	1,2	0,9	0,3	15
20	1,1	0,8	0,2	10
25	1,1	0,7	0,1	5
30	1,0	0,6	0,0	0
	—	—	—	
S	11	10	9	S
	+	+	+	
S	5	4	3	S

IV. For the Horary Motion of the Moon's Long.

Argument IV.
Argument of Longitude IV.

S	0	1	2	S
	—	—	—	
S	6	7	8	S
	+	+	+	
0	//	//	//	0
0	0,9	0,8	0,4	30
5	0,9	0,7	0,4	25
10	0,9	0,7	0,3	20
15	0,9	0,6	0,2	15
20	0,8	0,6	0,1	10
25	0,8	0,5	0,1	5
30	0,8	0,4	0,0	0
S	—	—	—	
	11	10	9	S
S	+	+	+	
	5	4	3	S

V. For the Horary Motion of the Moon's Longitude.

Argument V.
Argument of Longitude V.

S	0	1	2	3	4	5	S
	—	—	—	∓	+	+	
0	//	//	''	//	//	//	0
0	41,4	36,1	21,3	0,6	20,7	36,7	30
1	41,4	35,7	20,7	0,1	21,4	37,1	29
2	41,4	35,3	20,1	0,9	22,0	37,4	28
3	41,3	34,9	19,4	1,6	22,7	37,8	27
4	41,3	34,5	18,8	2,4	23,3	38,2	26
5	41,2	34,1	18,1	3,1	23,9	38,5	25
6	41,2	33,7	17,5	3,8	24,5	38,8	24
7	41,1	33,3	16,8	4,6	25,1	39,1	23
8	41,0	32,9	16,1	5,3	25,7	39,4	22
9	40,9	32,5	15,5	6,0	26,3	39,7	21
10	40,8	32,0	14,9	6,7	26,9	39,9	20
11	40,6	31,6	14,2	7,5	27,5	40,2	19
12	40,5	31,1	13,5	8,2	28,0	40,4	18
13	40,4	30,7	12,8	8,9	28,6	40,7	17
14	40,2	30,2	12,1	9,7	29,1	40,9	16
15	40,0	29,7	11,4	10,4	29,7	41,1	15
16	39,8	29,2	10,7	11,2	30,3	41,3	14
17	39,6	28,7	10,0	11,9	30,8	41,4	13
18	39,4	28,2	9,3	12,6	31,4	41,6	12
19	39,2	27,6	8,6	13,3	31,9	41,8	11
20	39,0	27,1	7,9	13,9	32,4	42,0	10
21	38,8	26,5	7,2	14,6	32,8	42,1	9
22	38,5	26,0	6,4	15,3	33,3	42,2	8
23	38,3	25,4	5,7	16,0	33,7	42,3	7
24	38,0	24,9	4,9	16,7	34,2	42,3	6
25	37,7	24,3	4,2	17,4	34,6	42,4	5
26	37,4	23,7	3,5	18,0	35,1	42,4	4
27	37,1	23,1	2,7	18,7	35,5	42,5	3
28	36,8	22,5	2,0	19,4	35,9	42,5	2
29	36,5	21,9	1,3	20,1	36,3	42,6	1
30	36,1	21,3	0,6	20,7	36,7	42,6	0
	—	—	—	∓	+	+	
S	11	10	9	8	7	6	S

VI. For Hor. Mot. ☽ Lo.

Argument VI.
Argument of Long. VI.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	//	0
0	1,1	0,9	0,5	30
5	1,1	0,9	0,5	25
10	1,1	0,8	0,4	20
15	1,0	0,8	0,3	15
20	1,0	0,7	0,2	10
25	1,0	0,6	0,1	5
30	0,9	0,5	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

VII. For Hor Mot. ☽ Lo.

Argument VII.
Argument of Long. VII.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	//	//	//	0
0	0,4	0,3	0,2	30
5	0,4	0,3	0,2	25
10	0,4	0,3	0,1	20
15	0,4	0,3	0,1	15
20	0,4	0,3	0,1	10
25	0,4	0,2	0,0	5
30	0,3	0,2	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

VIII. For Hor. Mot ☽ Lo.

Argument VIII.
Argument of Lon. VIII.

S	0	1	2	S
	+	+	+	
S	6	7	8	S
	—	—	—	
0	''	//	//	0
0	0,3	0,3	0,1	30
5	0,3	0,2	0,1	25
10	0,3	0,2	0,1	20
15	0,3	0,2	0,1	15
20	0,3	0,2	0,1	10
25	0,3	0,2	0,0	5
30	0,3	0,1	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

IX. For Horary Motion ☽'s Long.

Argument IX.
Argument of Longitude IX:

S	0	1	2	S
	—	—	—	
S	6	7	8	S
	+	+	+	
0	//	//	//	0
0	0,1	0,1	0,0	30
5	0,1	0,1	0,0	25
10	0,1	0,1	0,0	20
15	0,1	0,1	0,0	15
20	0,1	0,1	0,0	10
25	0,1	0,0	0,0	5
30	0,1	0,0	0,0	0
S	—	—	—	
	11	10	9	S
	+	+	+	
S	5	4	3	S

X. For the Horary Motion of the Moon 's Long.

Argument X.
Argument of Longitude X.

S	0	1	2	3	4	5	S
	+	∓	—	—	∓	+	
0	//	''	''	''	''	''	0
0	3,1	1,8	0,9	2,4	1,5	0,6	30
5	3,0	1,4	1,3	2,4	1,2	0,9	25
10	2,9	0,9	1,5	2,4	0,8	1,2	20
15	2,7	0,5	1,9	2,2	0,4	1,5	15
20	2,4	0,0	2,1	2,1	0,1	1,6	10
25	2,1	0,4	2,3	1,8	0,3	1,7	5
30	1,8	0,9	2,4	1,5	0,6	1,7	0
	+	∓	—	—	∓	+	
S	11	10	9	8	7	6	S

XI. For the horary Motion of the Moon's Long.

Arg. XI. Argument of Longitude XI.

S	0 +		1 +		2 +		3 +		4 +		5 +	
0	′	″	′	″	′	″	′	″	′	″	′	″
0	29	34,8	29	57,4	31	2,3	32	41,6	34	35,7	36	10,3
1	29	34,8	29	58,9	31	5,1	32	45,3	34	39,4	36	12,6
2	29	34,8	30	0,5	31	8,0	32	49,1	34	42,9	36	14,8
3	29	35,0	30	2,1	31	10,8	32	52,8	34	46,5	36	17,0
4	29	35,2	30	3,7	31	13,8	32	56,6	34	50,2	36	19,2
5	29	35,4	30	5,3	31	16,8	33	0,3	34	53,7	36	21,2
6	29	35,7	30	7,1	31	19,9	33	4,1	34	57,3	36	23,2
7	29	36,1	30	8,9	31	23,0	33	7,9	35	0,8	36	25,2
8	29	36,5	30	10,8	31	26,1	33	11,7	35	4,3	36	27,0
9	29	36,9	30	12,7	31	29,2	33	15,5	35	7,8	36	28,8
10	29	37,4	30	14,6	31	32,3	33	19,3	35	11,3	36	30,5
11	29	37,9	30	16,5	31	35,5	33	23,1	35	14,7	36	32,2
12	29	38,5	30	18,5	31	38,7	33	26,9	35	18,0	36	33,7
13	29	39,0	30	20,6	31	42,0	33	30,8	35	21,3	36	35,2
14	29	39,7	30	22,7	31	45,2	33	34,7	35	24,6	36	36,6
15	29	40,5	30	24,8	31	48,6	33	38,6	35	28,0	36	38,0
16	29	41,3	30	27,1	31	52,5	33	42,5	35	31,0	36	39,2
17	29	42,1	30	29,4	31	55,4	33	46,3	35	34.1	36	40,4
18	29	43,0	30	31,7	31	58,8	33	50,0	35	37,2	36	41,3
19	29	43,9	30	34,0	32	2,2	33	53,9	35	40,3	36	42,3
20	29	44,9	30	36,3	32	5,7	33	57,7	35	43,3	36	43,3
21	29	45,9	30	38,7	32	9,2	34	1,5	35	46,3	36	44,1
22	29	47,0	30	41,2	32	12,7	34	5,4	35	49,1	36	44,8
23	29	48,1	30	43,7	32	16,2	34	9,2	35	52,0	36	45,4
24	29	49,3	30	46,3	32	19,7	34	13,1	35	54,8	36	46,0
25	29	50,5	30	48,9	32	23,3	34	16,9	35	57,5	36	46,5
26	29	51,7	30	51,5	32	26,9	34	20,6	36	0,2	36	46,9
27	29	53,1	30	54,2	32	30,6	34	24,4	36	2,8	36	47,2
28	29	54,5	30	56,9	32	34,2	34	28,1	36	5,3	36	47,4
29	29	55,9	30	59,6	32	37,9	34	31,9	36	7,8	36	47,6
30	29	57,4	31	2,3	32	41,6	34	35,7	36	10,3	36	47,6
	+		+		+		+		+		+	
S	11		10		9		8		7		6	

XII. For the horary Motion of the Moon's Long.

Arg. XII. Argument of Longitude XII.

0 +	1 ±	2 —	3 —	4 ∓	5 +	S
′	″	″	″	″	′	
39,6	19,0	20,8	39,8	19,8	20,8	30
39,6	17,8	22,0	39,8	18,6	22,0	29
39,5	16,5	23,1	39,7	17,3	23,2	28
39,4	15,2	24,2	39,6	16,1	24,4	27
39,2	13,9	25,3	39,4	14,8	25,6	26
39,0	12,6	26,3	39,1	13,5	26,7	25
38,7	11,3	27,3	38,8	12,1	27,8	24
38,3	9,9	28,3	38,5	10,8	28,8	23
38,0	8,6	29,3	38,2	9,5	29,9	22
37,6	7,2	30,2	37,8	8,1	30,8	21
37,1	5,8	31,1	37,3	6,7	31,8	20
36,6	4,4	31,9	36,8	5,3	32,7	19
36,0	3,1	32,7	36,2	3,9	33,6	18
35,4	1,7	33,5	35,7	2,5	34,4	17
34,7	0,3	34,2	35,0	1,1	35,2	16
34,0	1,1	34,8	34,3	0,3	36,0	15
33,3	2,5	35,5	33,6	1,7	36,7	14
32,5	3,9	36,1	32,9	3,1	37,4	13
31,7	5,3	36,7	32,1	4,5	38,0	12
30,8	6,6	37,2	31,2	5,9	38,5	11
29,9	8,0	37,6	30,4	7,4	39,0	10
29,0	9,3	38,1	29,5	8,8	39,5	9
28,0	10,7	38,4	28,5	10,2	40,0	8
27,0	12,0	38,8	27,6	11,5	40,3	7
26,0	13,3	39,1	26,5	12,9	40,7	6
24,9	14,6	39,3	25,5	14,3	41,0	5
23,8	15,9	39,5	24,4	15,6	41,2	4
22,6	17,2	39,7	23,3	16,9	41,4	3
21,4	18,4	39,7	22,1	18,2	41,5	2
20,2	19,6	39,8	21,0	19,5	41,6	1
19,0	20,8	39,8	19,8	20,8	41,6	0
+	±	—	—	∓	+	
11	10	9	8	7	6	S

XIII. For the horary motion of ☽'s Long.

Arg. XIII. Arg. of Long. XIII.

S	0 +	1 +	2 +	S
S	6 —	7 —	8 —	S
0	″	″	″	0
0	0,8	0,7	0,4	30
5	0,8	0,7	0,3	25
10	0,8	0,6	0,3	20
15	0,8	0,6	0,2	15
20	0,8	0,5	0,2	10
25	0,7	0,5	0,1	5
30	0,7	0,4	0,0	0
	+	+	+	
S	11	10	9	S
	—	—	—	
S	5	4	3	S

For the horary Motion of the Moon's Longitude.

Arg. XIV. Argument of Longitude XIV.

S	0 +	1 ±	2 +	S
S	6 —	7 ∓	8 +	S
0	″	″	″	0
0	7,7	3,8	3,8	30
1	7,7	3,6	4,1	29
3	7,7	3,4	4,3	28
5	7,7	3,1	4,5	27
4	7,6	2,9	4,7	26
5	7,6	2,6	4,9	25
6	7,5	2,4	5,1	24
7	7,4	2,1	5,3	23
8	7,4	1,9	5,5	22
9	7,3	1,6	5,7	21
10	7,2	1,3	5,9	20
11	7,1	1,1	6,1	19
12	7,0	0,8	6,2	18
13	6,9	0,5	6,4	17
14	6,8	0,3	6,5	16
15	6,7	0,0	6,7	15
16	6,5	0,3	6,8	14
17	6,4	0,5	6,9	13
18	6,2	0,8	7,0	12

S	0 —	1 ±	2 +	S
S	6 —	7 ∓	8 +	S
0	″	″	″	0
19	6,1	1,1	7,1	11
20	5,9	1,3	7,2	10
21	5,7	1,6	7,3	9
22	5,5	1,9	7,4	8
23	5,3	2,1	7,5	7
24	5,1	2,4	7,5	6
25	4,9	2,6	7,6	5
26	4,7	2,9	7,6	4
27	4,5	3,1	7,7	3
28	4,3	3,4	7,7	2
29	4,1	3,6	7,7	1
30	3,8	3,8	7,7	0
	—	∓	+	
S	11	10	9	S
	—	∓	+	
S	5	4	3	S

The numbers taken from this Table should be added or subtracted in the mean ratio of the Moon's horary motion, which is 32′ 56″, to the Moon's hourly motion just found, when it appeareth that operation is useful.

For the Horary Motion of the Moon's Latitude.

Argument I. Argument of Latitude I.

S	0 +	1 +	2 +	S
S	6 —	7 —	8 —	S
°	′ ″	′ ″	′ ″	°
0	2 58,2	2 34,3	1 29,1	30
1	2 58,2	2 32,7	1 26,4	29
2	2 58,1	2 31,1	1 23,7	28
3	2 57,9	2 29,4	1 20,9	27
4	2 57,7	2 27,7	1 18,1	26
5	2 57,5	2 26,0	1 15,3	25
6	2 57,2	2 24,2	1 12,5	24
7	2 56,9	2 22,3	1 9,6	23
8	2 56,5	2 20,4	1 6,7	22
9	2 56,0	2 18,5	1 3,9	21
10	2 55,5	2 16,5	1 1,0	20
11	2 54,9	2 14,5	0 58,0	19
12	2 54,3	2 12,4	0 55,1	18
13	2 53,6	2 10,3	0 52,1	17
14	2 52,9	2 8,2	0 49,1	16
15	2 52,1	2 6,0	0 46,1	15
16	2 51,3	2 3,8	0 43,1	14
17	2 50,4	2 1,5	0 40,1	13
18	2 49,5	1 59,2	0 37,0	12
19	2 48,5	1 56,9	0 34,0	11
20	2 47,4	1 54,5	0 30,9	10
21	2 46,4	1 52,1	0 27,9	9
22	2 45,2	1 49,7	0 24,8	8
23	2 44,0	1 47,2	0 21,7	7
24	2 42,8	1 44,7	0 18,6	6
25	2 41,5	1 42,2	0 15,5	5
26	2 40,2	1 39,6	0 12,4	4
27	2 38,8	1 37,0	0 9,3	3
28	2 37,3	1 34,4	0 6,2	2
29	2 35,9	1 31,8	0 3,1	1
30	2 34,3	1 29,1	0 0,0	0
S	+ 11	+ 10	+ 9	S
S	— 5	— 4	— 3	S

Argument II. Argument of Latitude II.

S	0 +	1 +	2 +	S
S	6 —	7 —	8 —	S
°	″	″	″	°
0	4,3	3,7	2,1	30
1	4,3	3,7	2,1	29
2	4,3	3,6	2,0	28
3	4,3	3,6	1,9	27
4	4,3	3,5	1,9	26
5	4,3	3,5	1,8	25
6	4,3	3,4	1,7	24
7	4,3	3,4	1,7	23
8	4,3	3,4	1,6	22
9	4,2	3,3	1,5	21
10	4,2	3,3	1,5	20
11	4,2	3,2	1,4	19
12	4,2	3,2	1,3	18
13	4,2	3,1	1,2	17
14	4,1	3,1	1,2	16
15	4,1	3,0	1,1	15
16	4,1	3,0	1,0	14
17	4,1	2,9	1,0	13
18	4,1	2,9	0,9	12
19	4,1	2,8	0,8	11
20	4,0	2,7	0,7	10
21	4,0	2,7	0,7	9
22	4,0	2,6	0,6	8
23	4,0	2,6	0,5	7
24	3,9	2,5	0,5	6
25	3,9	2,4	0,4	5
26	3,8	2,4	0,3	4
27	3,8	2,3	0,2	3
28	3,8	2,3	0,1	2
29	3,8	2,2	0,1	1
30	3,7	2,1	0,0	0
S	+ 11	+ 10	+ 9	S
S	— 5	— 4	— 3	S

The quantity and difference of these Equations, as the sign signifies, is increased or diminished in proportion to the mean horary motion of the Moon, which is 32′. 56″, to the horary motion of the Moon in her proper orbit.

Eclipſes of Jupiter's Satellites.

Sect. XI. *The method of finding the Longitude by the Eclipſes of Jupiter's Satelliites; the amazing Velocity of Light demonſtrated by theſe Eclipſes; and of Cometary Eclipſes.*

In the former ſection, having explained at great length how eclipſes of the ſun and moon happen at certain times, it muſt be evident, that ſimilar eclipſes will be obſerved by the inhabitants of Jupiter and Saturn, which are attended by ſo many moons. Theſe
482 Frequency of theſe eclipſes. eclipſes indeed very frequently happen to the ſatellites of Jupiter; and as they are of the greateſt ſervice in determining the longitude of places on this earth, aſtronomers have been at great pains to calculate tables for the eclipſes of theſe ſatellites by their primary, for the ſatellites themſelves have never been obſerved to eclipſe one another. The conſtruction of ſuch tables is indeed much eaſier for theſe ſatellites than of any other celeſtial bodies, as their motions are much more regular.

The Engliſh tables are calculated for the meridian of Greenwich, and by theſe it is very eaſy to find how many degrees of longitude any place is diſtant either eaſt or weſt from Greenwich; for, let an obſerver, who has theſe tables, with a good teleſcope and a well-regulated clock at any other place of the earth, obſerve the beginning or ending of an eclipſe of one of Jupiter's ſatellites, and note the preciſe moment of time that he ſaw the ſatellite either immerge into, or emerge out of the ſhadow, and compare that time with the time ſhown by the tables for Greenwich; then 15 degrees difference of longitude being allowed for every hour's difference of time, will give the longitude of that place from Greenwich; and if there be any odd minutes of time, for every minute a quarter of a degree, eaſt or weſt, muſt be allowed, as the time of obſervation is later or earlier than the time ſhown by the tables. Such eclipſes are very convenient for this purpoſe at land, becauſe they happen almoſt every day; but are of no uſe at ſea, becauſe the rollings of the ſhip hinders all nice teleſcopical obſervations.

To explain this by a figure, let J be Jupiter, K, L, M, N his four ſatellites in their reſpective orbits,
Fig. 177. 1, 2, 3, 4; and let the earth be at F (ſuppoſe in November, although that month is no otherwiſe material than to find the earth readily in this ſcheme, where it is ſhown in eight different parts of the orbit). Let Q be a place on the meridian of Greenwich, and R a place on ſome other meridian eaſtward from Greenwich. Let a perſon at R obſerve the inſtantaneous vaniſhing of the firſt ſatellite K into Jupiter's ſhadow, ſuppoſe at three o'clock in the morning; but by the tables he finds the immerſion of that ſatellite to be at midnight at Greenwich; he then can immediately determine, that as there are three hours difference of time between Q and K, and that R is three hours forwarder in reckoning than Q, it muſt be 45 degrees of eaſt longitude from the meridian of Q. Were this
483 When the immerſions or emerſions are to be obſerved. method as practicable at ſea as at land, any ſailor might almoſt as eaſily, and with equal certainty, find the longitude as the latitude.

Whilſt the earth is going from C to F in its orbit, only the immerſions of Jupiter's ſatellites into his ſhadow are generally ſeen; and their emerſions out of it while the earth goes from G to B. Indeed, both theſe appearances may be ſeen of the ſecond, third, and fourth ſatellite when eclipſed, whilſt the earth is between D and E, or between G and A; but never of the firſt ſatellite, on account of the ſmallneſs of its orbit and the bulk of Jupiter, except only when Jupiter is directly oppoſite to the ſun, that is, when the earth is at G; and even then, ſtrictly ſpeaking, we cannot ſee either the immerſions or emerſions of any of his ſatellites, becauſe his body being directly between us and his conical ſhadow, his ſatellites are hid by his body a few moments before they touch his ſhadow; and are quite emerged from thence before we can ſee them, as it were juſt dropping from him. And when the earth is at C, the ſun, being between it and Jupiter, hides both him and his moons from us. Eclipſes of Jupiter's Satellites.

In this diagram, the orbits of Jupiter's moons are drawn in true proportion to his diameter; but in proportion to the earth's orbit, they are drawn vaſtly too large.

In whatever month of the year Jupiter is in conjunction with the ſun, or in oppoſition to him, in the next year it will be a month later at leaſt. For whilſt the earth goes once round the ſun, Jupiter deſcribes a twelfth part of his orbit. And therefore, when the earth has finiſhed its annual period, from being in a line with the ſun and Jupiter, it muſt go as much forwarder as Jupiter has moved in that time, to overtake him again; juſt like the minute-hand of a watch, which muſt, from any conjunction with the hour-hand, go once round the dial-plate and ſomewhat above a twelfth part more, to overtake the hour-hand again.

484 Velocity of light. It is found by obſervation, that when the earth is between the ſun and Jupiter, as at G, his ſatellites are eclipſed about 8 minutes ſooner than they ſhould be according to the tables; and when the earth is at B or C, theſe eclipſes happen about 8 minutes later than the tables predict them. Hence it is undeniably certain, that the motion of light is not inſtantaneous, ſince it takes about 16½ minutes of time to go through a ſpace equal to the diameter of the earth's orbit, which is 180,000,000 of miles in length; and conſequently the particles of light fly almoſt 200,000 miles every ſecond of time, which is above a milion of times ſwifter than the motion of a cannon bullet. And as light is 16½ minutes in travelling acroſs the earth's orbit, it muſt be 8¼ minutes in coming from the ſun to us: therefore if the ſun were annihilated, we ſhould ſee him for 8¼ minutes after; and if he were again created, he would be 8¼ minutes old before we could ſee him.

To illuſtrate this progreſſive motion of light, let A and B be the earth in two different parts of its orbit, whoſe diſtance from each other is 95,000,000 of miles, equal to the earth's diſtance from the ſun S. It is Fig. 178. plain, that if the motion of light were inſtantaneous, the ſatellite 1 would appear to enter into Jupiter's ſhadow FF at the ſame moment of time to a ſpectator in A, as to another in B. But by many years obſervations it has been found, that the immerſion of the ſatellite into the ſhadow is ſeen 8¼ minutes ſooner when the earth is at B than when it is at A. And ſo, as Mr Romeur firſt diſcovered, the motion of light is thereby proved to be progreſſive, and not inſtanta-

Eclipſes of Jupiter's Satellites.

neous, as was formerly believed. It is eaſy to compute in what time the earth moves from A to B; for the chord of 60 degrees of any circle is equal to the ſemidiameter of that circle: and as the earth goes through all the 360 degrees of its orbit in a year, it goes through 60 of thoſe degrees in about 61 days. Therefore, if on any given day, ſuppoſe the firſt of June, the earth is at A, on the firſt of Auguſt it will be at B; the chord, or ſtraight line AB, being equal to DS the radius of the earth's orbit, the ſame with AS its diſtance from the ſun.

As the earth moves from D to C, thro' the ſide AB of its orbit, it is conſtantly meeting the light of Jupiter's ſatellites ſooner, which occaſions an apparent acceleration of their eclipſes; and as it moves through the other half H of its orbit, from C to D, it is receding from their light, which occaſions an apparent retardation of their eclipſes, becauſe their light is then longer before it overtakes the earth.

485 Acceleration of theſe eclipſes not owing to any inequality in the motions of the ſatellites.

That theſe accelerations of the immerſions of Jupiter's ſatellites into his ſhadow, as the earth approaches towards Jupiter, and the retardations of their emerſions out of his ſhadow, as the earth is going from him, are not occaſioned by any inequality ariſing from the motions of the ſatellites in eccentric orbits, is plain, becauſe it affects them all alike, in whatever parts of their orbits they are eclipſed. Beſides, they go often round their orbits every year, and their motions are no way commenſurate to the earth's. Therefore, a phenomenon not to be accounted for from the real motions of the ſatellites, but ſo eaſily deducible from the earth's motion, and ſo anſwerable thereto, muſt be allowed to reſult from it. This affords one very good proof of the earth's annual motion.

486 Eclipſes by comets.

From what we have ſaid in general concerning eclipſes, it is plain that ſecondary planets are not the only bodies that may occaſion them. The primary planets would eclipſe one another, were it not for their great diſtances; but as the comets are not ſubject to the ſame laws with the planets, it is poſſible they may ſometimes approach ſo near to the primary planets, as to cauſe an eclipſe of the ſun to thoſe planets; and as the body of a comet bears a much larger proportion to the bulk of a primary planet than any ſecondary, it is plain that a cometary eclipſe would both be of much longer continuance, and attended with much greater darkneſs, than that occaſioned by a ſecondary planet. This behoved to be the caſe at any rate: but if we ſuppoſe the primary planet and comet to be moving both the ſame way, the duration of ſuch an eclipſe would be prodigiouſly lengthened; and thus, inſtead of four minutes, the ſun might be totally darkened to the inhabitants of certain places for as many hours. Hence we may account for that prodigious darkneſs which we ſometimes read of in hiſtory at times when no eclipſe of the ſun by the moon could poſſibly happen. It is remarkable, however, that no comet hath ever been obſerved paſſing over the diſk of the ſun like a ſpot, as Venus and Mercury are; yet this muſt certainly happen, when the comet is in its perihelion, and the earth on the ſame ſide of its annual orbit. Such a phenomenon well deſerves the watchful attention of aſtronomers, as it would be a greater confirmation of the planetary nature of comets than any thing hitherto obſerved.

Aſtronomical Machinery.

Sect. XII. *A Deſcription of the Aſtronomical Machinery ſerving to explain and illuſtrate the foregoing part of this Treatiſe.*

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The machine repreſented by fig. 207. is the Grand Orrery, firſt made in this kingdom by Mr Rowley for King George I. The frame of it, which contains the wheel-work, &c. and regulates the whole machine, is made of ebony, and about four feet in diameter; the outſide thereof is adorned with 12 pilaſtres. Between theſe the 12 ſigns of the zodiac are neatly painted with gilded frames. Above the frame is a broad ring ſupported with 12 pillars. This ring repreſents the plane of the ecliptic; upon which are two circles of degrees, and between theſe the names and characters of the 12 ſigns. Near the outſide is a circle of months and days, exactly correſponding to the ſun's place at noon each day throughout the year. Above the ecliptic ſtand ſome of the principal circles of the ſphere, agreeable to their reſpective ſituations in the heavens: viz. N° 10. are the two colures, divided into degrees and half degrees; N° 11. is one-half of the equinoctial circle, making an angle of 23½ degrees. The tropic of cancer and the arctic circle are each fixed parallel at their proper diſtance from the equinoctial. On the northern half of the ecliptic is a braſs ſemicircle, moveable upon two points fixed in ♈ and ♎. This ſemicircle ſerves as a moveable horizon to be put to any degree of latitude upon the north part of the meridian, and the whole machine may be ſet to any latitude without diſturbing any of the internal motions, by two ſtrong hinges (N° 13.) fixed to the bottom-frame upon which the inſtrument moves, and a ſtrong braſs arch, having holes at every degree, through which a ſtrong pin is put at every elevation. This arch and the two hinges ſupport the whole machine when it is lifted up according to any latitude; and the arch at other times lies conveniently under the bottom-frame. When the machine is ſet to any latitude (which is eaſily done by two men, each taking hold of two handles conveniently fixed for the purpoſe), ſet the moveable horizon to the ſame degree upon the meridian, and hence you may form an idea of the reſpective altitude or depreſſion of the planets both primary and ſecondary. The ſun (N° 1.) ſtands in the middle of the whole ſyſtem upon a wire, making an angle with the ecliptic of about 82 degrees. Next the ſun is a ſmall ball (2.), repreſenting Mercury. Next to Mercury is Venus (3.), repreſented by a larger ball. The earth is repreſented (N° 4.) by an ivory ball, having ſome circles and a map ſketched upon it. The wire which ſupports the earth makes an angle with the ecliptic of 66½ degrees, the inclination of the earth's axis to the ecliptic. Near the bottom of the earth's axis is a dial-plate (N° 9.), having an index pointing to the hours of the day as the earth turns round its axis. Round the earth is a ring ſupported by two ſmall pillars, repreſenting the orbit of the moon; and the diviſions upon it anſwer to the moon's latitude. The motion of this ring repreſents the motion of the moon's orbit according to that of the nodes. Within this ring is the moon (N° 5.), having a black cap or caſe, by which its motion repreſents the phaſes of the moon according to her age. Without the orbits of the

Astronomical Machinery.

the earth and moon is Mars (N° 6.) The next in order to Mars is Jupiter and his four moons (N° 7.) Each of these moons is supported by a wire fixed in a socket which turns about the pillar supporting Jupiter. These satellites may be turned by the hand to any position, and yet when the machine is put into motion they will all move in their proper times. The outermost of all is Saturn, his five moons, and his ring (N° 8.). These moons are supported and contrived similar to those of Jupiter. The machine is put into motion by turning a small winch (N° 14,); and the whole system is also moved by this winch, and by pulling out and pushing in a small cylindrical pin above the handle. When it is pushed in, all the planets, both primary and secondary, will move according to their respective periods by turning the handle. When it is drawn out, the motions of the satellites of Jupiter and Saturn will be stopped while all the rest move without interruption. There is also a brass lamp having two convex glasses to be put in room of the sun; and also a smaller earth and moon, made somewhat in proportion to their distance from each other, which may be put on at pleasure. The lamp turns round at the same time with the earth, and the glasses of it cast a strong light upon her. And when the smaller earth and moon are placed on, it will be easy to show when either of them will be eclipsed. When this machine is intended to be used, the planets must be duly placed by means of an ephemeris hereafter described; and you may place a small black patch or bit of wafer upon the middle of the sun. Right against the first degree of ♈, you may also place patches upon Venus, Mars, and Jupiter, right against some noted point in the ecliptic. Put in the handle, and push in the pin which is above it. One turn of this handle answers to a revolution of the ball which represents the earth about its axis; and consequently to 24 hours of time, as shown by the hour-index (9.), which is marked and placed at the foot of the wire on which the ball of the earth is fixed. Again, when the index has moved the space of ten hours, Jupiter makes one revolution round its axis, and so of the rest. By these means the revolutions of the planets, and their motions round their own axes, will be represented to the eye. By observing the motions of the spots upon the surface of the sun and of the planets in the heavens, their diurnal motion was first discovered, after the same manner as we in this machine observe the motions of their representatives by that of the marks placed upon them.

488 The Orrery (fig. 208.) is a machine contrived by the late ingenious Mr James Ferguson. It shows the motions of the sun, Mercury, Venus, earth, and moon; and occasionally the superior planets, Mars, Jupiter, and Saturn, may be put on. Jupiter's four satellites are moved round him in their proper times by a small winch; and Saturn has his five satellites, and his ring which keeps its parallelism round the sun; and by a lamp put in the sun's place, the ring shows all its various phases already described.

In the centre, N° 1. represents the sun, supported by its axis, inclining almost 8 degrees from the axis of the ecliptic, and turning round in 25½ days on its axis, of which the north pole inclines toward the eighth degree of Pisces in the great ecliptic (N° 11.), whereon the months and days are engraven over the signs and degrees in which the sun appears, as seen from the earth, on the different days of the year.

Astronomical Machinery.

The nearest planet (N° 2.) to the sun is Mercury, which goes round him in 87 days 23 hours, or 87¼ diurnal rotations of the earth; but has no motion round its axis in the machine, because the time of its diurnal motion in the heavens is not known to us.

The next planet in order is Venus (N° 3.), which performs her annual course in 224 days 17 hours, and turns round her axis in 24 days 8 hours, or in 24½ diurnal rotations of the earth. Her axis inclines 75 degrees from the axis of the ecliptic, and her north pole inclines towards the 20th degree of Aquarius, according to the observations of Bianchini. She shows all the phenomena described in Sect. ii.

Next, without the orbit of Venus, is the earth (N° 4.), which turns round its axis, to any fixed point at a great distance, in 23 hours 56 minutes 4 seconds of mean solar time; but from the sun to the sun again, in 24 hours of the same time. N° 6. is a sidereal dial-plate under the earth, and N° 7. a solar dial-plate on the cover of the machine. The index of the former shows sidereal, and of the latter, solar time; and hence the former index gains one entire revolution on the latter every year, as 365 solar or natural days contain 366 sidereal days, or apparent revolutions of the stars. In the time that the earth makes 365 ¼ diurnal rotations on its axis, it goes once round the sun in the plane of the ecliptic; and always keeps opposite to a moving index (N° 10.) which shows the sun's daily change of place, and also the days of the months.

The earth is half covered with a black cap, for dividing the apparently enlightened half next the sun from the other half, which, when turned away from him, is in the dark. The edge of the cap represents the circle bounding light and darkness, and shows at what time the sun rises and sets to all places throughout the year. The earth's axis inclines 23½ degrees from the axis of the ecliptic: the north pole inclines toward the beginning of Cancer, and keeps its parallelism throughout its annual course; so that in summer the northern parts of the earth incline towards the sun, and in winter from him: by which means, the different length of days and nights, and the cause of the various seasons, are demonstrated to sight.

There is a broad horizon, to the upper side of which is fixed a meridian semicircle in the north and south points, graduated on both sides from the horizon to 90° in the zenith or vertical point. The edge of the horizon is graduated from the east and west to the south and north points, and within these divisions are the points of the compass. From the lower side of this thin horizontal plate stand out four small wires, to which is fixed a twilight-circle 18 degrees from the graduated side of the horizon all round. This horizon may be put upon the earth (when the cap is taken away), and rectified to the latitude of any place; and then by a small wire called the *solar ray*, which may be put on so as to proceed directly from the sun's centre towards the earth's, but to come no farther than almost to touch the horizon. The beginnnig of twilight, time of sunrising, with his amplitude, meridian altitude, time of setting, amplitude then, and end of twilight, are shown for every day of the year, at that place to which the horizon is rectified.

Aſtronomical Machinery.

The moon (N° 5.) goes round the earth, from between it and any fixed point at a great diſtance, in 27 days 7 hours 43 minutes, or through all the ſigns and degrees of her orbit, which is called her *periodical revolution*; but ſhe goes round from the ſun to the ſun again, or from change to change, in 29 days 12 hours 35 minutes, which is her *ſynodical revolution*; and in that time ſhe exhibits all the phaſes already deſcribed.

When the abovementioned horizon is rectified to the latitude of any given place, the times of the moon's riſing and ſetting, together with her amplitude, are ſhown to that place as well as the ſun's; and all the various phenomena of the harveſt-moon are made obvious to ſight.

The moon's orbit (N° 9.) is inclined to the ecliptic (N° 11.), one-half being above and the other below it. The nodes, or points at ☊ and ☋, lie in the plane of the ecliptic, as before deſcribed, and ſhift backward through all its ſines and degrees in 18½ years. The degrees of the moon's latitude to the higheſt at NL (north latitude) and loweſt at SL (ſouth latitude), are engraven both ways from her nodes at ☊ and ☋, and as the moon riſes and falls in her orbit according to its inclination, her latitude and diſtance from her nodes are ſhown for every day, having firſt rectified her orbit ſo as to ſet the nodes to their proper places in the ecliptic; and then as they come about at different and almoſt oppoſite times of the year, and then point towards the ſun, all the eclipſes may be ſhown for hundreds of years (without any new rectification), by turning the machinery backward for time paſt, or forward for time to come. At 17 degrees diſtance from each node, on both ſides, is ingraved a ſmall ſun; and at 12 degrees diſtance, a ſmall moon, which ſhow the limits of ſolar and lunar eclipſes; and when, at any change, the moon falls between either of theſe ſuns and the node, the ſun will be eclipſed on the day pointed to by the annual-index (N° 10.); and as the moon has then north or ſouth latitude, one may eaſily judge whether that eclipſe will be viſible in the northern or ſouthern hemiſphere: eſpecially as the earth's axis inclines toward the ſun or from him at that time. And when at any full the moon falls between either of the little moon's and node, ſhe will be eclipſed, and the annual-index ſhows the day of that eclipſe. There is a circle of 29 equal parts (N° 8.) on the cover of the machine, on which an index ſhows the days of the moon's age.

There are two ſemicircles (fig. 216.) fixed to an elliptical ring, which being put like a cap upon the earth, and the forked part F upon the moon, ſhows the tides as the earth turns round within them, and they are led round it by the moon. When the different places come to the ſemicircle *AaEbB*, they have tides of flood; and when they come to the ſemicircle CED, they have tides of ebb; the index on the hour-circle (fig. 208.) ſhowing the times of theſe phenomena.

There is a jointed wire, of which one end being put into a hole in the upright ſtem that holds the earth's cap, and the wire laid into a ſmall forked piece which may be occaſionally put upon Venus or Mercury, ſhows the direct and retrograde motions of theſe two planets, with their ſtationary times and places, as ſeen from the earth.

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The whole machinery is turned by a winch or handle (N° 12.); and is ſo eaſily moved, that a clock might turn it without any danger of ſtopping.

To give a plate of the wheel-work of this machine would anſwer no purpoſe, becauſe many of the wheels lie ſo behind others as to hide them from ſight in any view whatever.

The PLANETARIUM (fig. 209.) is an inſtrument 489
contrived by Mr William Jones of Holburn, London, mathematical inſtrument maker, who has paid conſiderable attention to thoſe ſort of machines, in order to reduce them to their greateſt degree of ſimplicity and perfection. It repreſents, in a general manner, by various parts of its machinery, all the motions and phenomena of the planetary ſyſtem. This machine conſiſts of, the Sun (in the centre), with the planets, Mercury, Venus, the Earth and Moon, Mars, Jupiter and his four moons, Saturn and his five moons; and to it is occaſionally applied an extra long arm for the Georgian planet and his two moons. To the earth and moon is applied a frame CD, containing only four wheels and two pinions, which ſerve to preſerve the earth's axis in its proper parallelism in its motion round the ſun, and to give the moon her due revolution about the earth at the ſame time. Theſe wheels are connected with the wheel-work in the round box below, and the whole is ſet in motion by the winch H. The arm M that carries round the moon, points out on the plate C her age and phaſes for any ſituation in her orbit, and which accordingly are engraved thereon. In the ſame manner the arm points out her place in the ecliptic B, in ſigns and degrees, called her geocentric place; that is, as ſeen from the earth. The moon's orbit is repreſented by the flat rim A; the two joints of which, and upon which it turns, denoting her nodes. This orbit is made to incline to any deſired angle. The earth of this inſtrument is uſually made of a three inch or 1¼ globe, papered, &c. for the purpoſe; and by means of the terminating wire that goes over it, points out the changes of the ſeaſons, and the different lengths of days and nights more conſpicuouſly. This machine is alſo made to repreſent the Ptolemaic Syſtem, or ſuch as is vulgarly received; which places the earth in the centre, and the planets and ſun revolving about it. (It is done by an auxiliary ſmall ſun and an earth, which change their places in the inſtrument.) At the ſame time, it affords a moſt manifeſt confutation of it: for it is plainly obſerved by this conſtruction, (1.) That the planets Mercury and Venus being both within the orbit of the ſun, cannot at any time be ſeen to go behind it; whereas in nature we obſerve them as often to go behind as before the ſun in the heavens. (2.) It ſhows, that as the planets move in circular orbits about the central earth, they ought at all times to be of the ſame apparent magnitude; whereas, on the contrary, we obſerve their apparent magnitude in the heavens to be very variable, and ſo far different, that, for inſtance, Mars will ſometimes appear as big as Jupiter nearly, and at other times you will ſcarcely know him from a fixed ſtar. (3.) It ſhows that any of the planets might be ſeen at all diſtances from the ſun in the heavens; or, in other words, that when the ſun is ſetting, Mercury or Venus may be ſeen not only in the ſouth but even in the eaſt; which circumſtances were never yet obſerved. (4.)

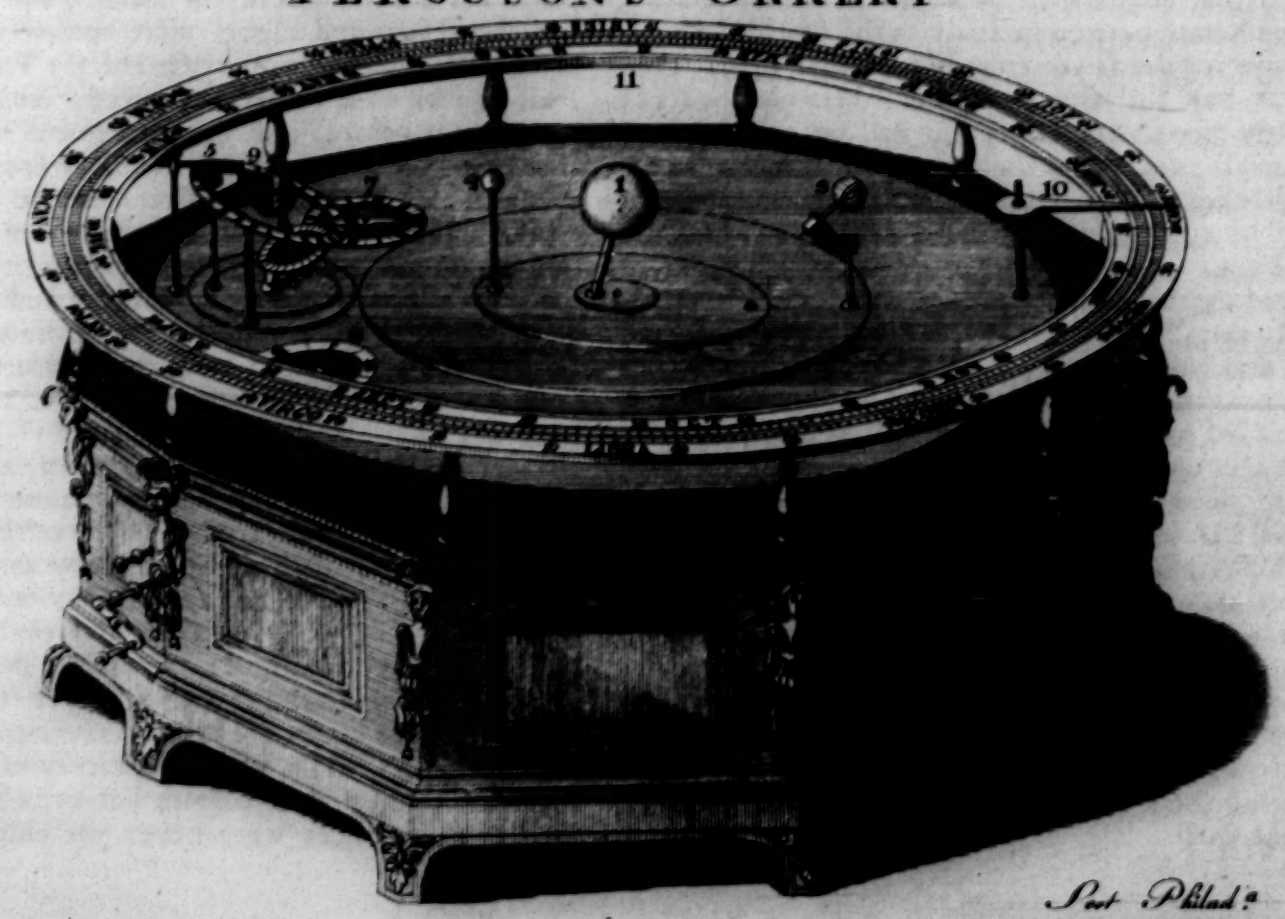
You

ASTRONOMY Plate LXXXVII

Fig. 207 The GRAND ORRERY by Rowley

Fig. 208

FERGUSONS ORRERY



Scot Philad.a

BRITISH MUSEUM

Aſtronomical Machinery.

You ſee by this planetarium that the motions of the planets ſhould always be regular and uniformly the ſame; whereas on the contrary, we obſerve them always to move with a variable velocity, ſometimes faſter, then ſlower, and ſometimes not at all, as will be preſently ſhown. (5.) By the machine you ſee the planets move all the ſame way, viz. from weſt to eaſt continually: but in the heavens we ſee them move ſometimes direct from weſt to eaſt, ſometimes retrograde from eaſt to weſt, and at other times to be ſtationary. All which phenomena plainly prove this ſyſtem to be a falſe and abſurd hypotheſis.

The truth of the Copernican or Solar Syſtem of the world is hereby moſt clearly repreſented. For taking the earth from the *centre*, and placing thereon the uſual large braſs ball for the ſun, and reſtoring the earth to its proper ſituation among the planets, then every thing will be right and agree exactly with celeſtial obſervations. For turning the winch H, (1.) You will ſee the planets Mercury and Venus go both before and behind the ſun, or have two conjunctions. (2.) You will obſerve Mercury never to be more than a certain angular diſtance, 21°, and Venus 47°, from the ſun. (3.) That the planets, eſpecially Mars, will be ſometimes much nearer to the earth than at others, and therefore muſt appear larger at one time than at another. (4.) You will ſee that the planets cannot appear at the earth to move with an uniform velocity; for when neareſt they appear to move faſter, and ſlower when moſt remote. (5.) You will obſerve the planets will appear at the earth to move ſometimes directly from weſt to eaſt, and then to become retrograde from eaſt to weſt, and between both to be ſtationary or without any apparent motion at all. Which particulars all correſpond exactly with obſervations, and fully prove the truth of this excellent ſyſtem. Fig. 211. repreſents an apparatus to ſhow theſe latter particulars more evidently. An hollow wire, with a ſlit at top, is placed over the arm of the planet Mercury or Venus at E. The arm DG repreſents a ray of light coming from the planet at D to the earth, and is put over the centre which carries the earth at F. The planets being then put in motion, the planet D, as ſeen in the heavens from the earth at F, will undergo the ſeveral changes of poſition as above deſcribed. The wire prop that is over Mercury at E, may be placed over the other ſuperior planets, Mars, &c. and the ſame phenomena may be exhibited.

By this machine you at *once* ſee all the planets in motion about the ſun, with the ſame reſpective velocities and periods of revolution which they have in the heavens; the wheel-work being calculated to a minute of time, from the lateſt diſcoveries.

You will ſee here a demonſtration of the earth's motion about the ſun, as well as thoſe of the reſt of the planets: for if the earth were to be at reſt in the heavens, then the time between any two conjunctions of the ſame kind, or oppoſitions, would be the ſame with the periodical time of the planets, viz. 88 days in Mercury, 225 in Venus, &c.: whereas you here obſerve this time, inſtead of being 225 days, is no leſs than 583 days in Venus, occaſioned by the earth's moving in the mean time about the ſun the ſame way with the planet. And this ſpace of 583 days always paſſes between two like conjunctions of Venus in the heavens. Hence the moſt important point of aſtronomy is ſatisfactorily demonſtrated.

Aſtronomical Machinery.

The diurnal rotation of the earth about its axis, and a demonſtration of the cauſe of the different ſeaſons of the year, and the different lengths of days and nights, are here anſwered completely: for as the earth is placed on an axis inclining to that of the ecliptic in an angle of 23½ degrees, and is ſet in motion by the wheel-work, there will be evidently ſeen the different inclination of the ſun's rays on the earth, the different quantity thereof which falls on a given ſpace, the different quantity of the atmoſphere they paſs through, and the different continuance of the ſun above the horizon at the ſame place in different times of the year; which particulars conſtitute the difference betwixt heat and cold in the ſummer and winter ſeaſons.

As the globe of the earth is moveable about its inclined axis, ſo by having the horizon of London drawn upon the ſurface of it, and by means of the terminating wire going over it, by which is denoted, that on that ſide of the wire next the ſun is the enlightened half of the earth, and the oppoſite ſide the darkened half, you will here ſee very naturally repreſented the cauſe of the different lengths of day and night, by obſerving the unequal portions of the circle which the iſland of Great-Britain, or the city of London, or any other place, deſcribes in the light and dark hemiſpheres at different times of the year, by turning the earth on its axis with the hand. But in ſome of the better orreries on this principle, the earth revolves about its axis by wheel-work.

As to the eclipſes of the ſun and moon, the true cauſes of them are here very clearly ſeen: for by placing the lamp (fig. 212,) upon the centre, in room of the braſs ball denoting the ſun, and turning the winch until the moon comes into a right line betwen the centers of the lamp (or ſun) and earth, the ſhadow of the moon will fall upon the earth, and all who live on that part over which the ſhadow paſſes will ſee the ſun eclipſed more or leſs. On the other ſide, the moon paſſes (in the aforeſaid caſe) through the ſhadow of the earth, and is by that means eclipſed. And the orbit A (fig. 210.) is ſo moveable on the two joints called nodes, that any perſon may eaſily repreſent the due poſition of the modes and intermediate ſpaces of the moon's orbit; and thence ſhow when there will or will not be an eclipſe of either luminary, and what the quantity of each will be.

While the moon is continuing to move round the earth, the lamp on the centre will ſo illumine the moon, that you will eaſily ſee all the phaſes, as new, dichotomized, gibbous, full, waining, &c. juſt as they appear in the heavens. You will moreover obſerve all the ſame phaſes of the earth as they appear at the moon.

The ſatellites of Jupiter and Saturn are moveable only by the hand; yet may all their phenomena be eaſily repreſented, excepting the true relative motions and diſtances. Thus, if that gilt globe which before repreſented the ſun be made now to denote Jupiter, and four of the primary planets only be retained, then will the Jovian ſyſtem be repreſented; and by candle light only you will ſee (the machine being in motion) the immerſions and emerſions of the ſatellites into and out of Jupiter's ſhadow. You will ſee plainly the manner in which they tranſit his body, and their occultations

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culations behind it. You will obſerve the various ways in which one or more of theſe moons may at times diſappear. And if the machine be ſet by a white wall, &c. then by the projection of their ſhadows will be ſeen the reaſons why thoſe moons always appear on each ſide of Jupiter in a right line, why thoſe which are moſt remote may appear neareſt, and *è contrario*. And the ſame may be done for Saturn's five moons and his ring.

490 *The Method of Rectifying the Orrery, and the proper Manner of placing the Planets in their true Situations.*

Having dwelled thus much on the deſcription of orreries, it may be uſeful to young readers, to point out the method by which the orrery ſhould be firſt rectified, previous to the exhibition or uſing of it: and the following is extracted from Mr William Jones's deſcription of his new *Portable Orrery*, "The method of ſhowing the places, and relative aſpects of the planets on any day of the year in the planetarium, muſt be done by the aſſiſtance of an *ephemeris* or *almanac*, which among other almanacs is publiſhed annually by the Stationer's Company. Aſtronomical Machinery.

"This ephemeris contains a diary or daily account of the planets places in the heavens, in ſigns, degrees, and minutes, both as they appear to the eye ſuppoſed to be at the ſun, and at the earth, throughout the year. The firſt of theſe poſitions is called the *heliocentric place*, and the latter, the *geocentric place*. The heliocentric place is that made uſe of in orreries; the geocentric place, that in globes. As an example for finding their places, and ſetting them right in the orrery, we will ſuppoſe the ephemeris (by *White*, which for this purpoſe is conſidered the beſt) at hand, wherein at the bottom of the *left-hand* page for every month is the heliocentric longitudes (or places) of all the planets to every ſix days of the month; which is near enough for common uſe: a copy of one of theſe tables for March 1784 is here inſerted for the information of the tyro.

Days	Day increaſ.	Helioc. long. ♄	Helioc. long. ♅	Helioc. long. ♂	Helioc. long. ☉	Helioc. long. ♀	Helioc. long. ☿
1	3 11	16 ♑ 45	17 ♒ 11	1 ♋ 30	11 ♍ 37	0 ♐ 35	7 ♏ 58
7	3 35	16 56	17 43	4 23	17 37	10 7	25 23
13	3 59	17 7	18 15	7 15	23 36	19 38	11 ♐ 59
19	4 23	17 17	18 47	10 6	29 33	29 8	28 33
25	4 47	17 28	19 19	12 55	5 ♎ 30	8 ♑ 38	15 ♑ 49

Now, as an example, we will ſuppoſe, that in order to ſet the planets of the orrery, we want their heliocentric places for the 21ſt of this month. Looking into the table, we take the 19th day, which is the neareſt to the day wanted: then, accordingly we find the place of Saturn (♄) is in 17° 17′, or 17 degrees (rejecting the minutes, being in this caſe uſeleſs); of Capricornus (♑), of Jupiter (♅), in 18° of Aquarius (♒), Mars (♂) in 10° of Cancer (♋), the earth (☉), in 29° of Virgo (♍), Venus (♀), in 29° of Sagittarius (♐), Mercury (☿) in 28° of the ſame ſign; and in the ſame manner for any other day therein ſpecified. Upon even this circumſtance depends a very pleaſing aſtronomical praxis, by which the young tyro may at any time be able to entertain himſelf in a moſt rational and agreeable manner, viz. he may in a minute or two repreſent the true appearance of the planetary ſyſtem juſt as it really is in the heavens, and for any day he pleaſes, by aſſigning to each planet its proper place in its orbit; as in the following manner: For the 19th of March, as before, the place of Saturn is in 17° of Capricornus (♑); now, laying hold of the arm of Saturn in the orrery, you place it over or againſt the 17° of Capricorn on the ecliptic circle, conſtantly placed on or ſurrounding the inſtrument: thus doing the ſame for the other planets, they will have their proper heliocentric places for that day.

"Now in this ſituation of the planets, we obſerve, that if a perſon was placed on the earth, he would ſee Venus and Jupiter in the ſame line and place of the ecliptic, conſequently in the heavens they would appear together, or in conjunction; Mercury a little to the left or eaſtward of them, and nearer to the ſun; Saturn to the right, or the weſtward, farther from the Sun; Mars directly oppoſite to Saturn; ſo that when Saturn appears in the weſt, Mars appears in the eaſt, and *vice verſa*. Several other curious and entertaining particulars as depending on the above, may be eaſily repreſented and ſhown by the learner, particularly the foregoing when the winch is turned, and all the planets ſet into their reſpective motions."

We cannot cloſe this detail on orreries more agree- 491
ably than by the following account of an inſtrument of that ſort invented by Mr. James Ferguſon, to which he gives the name of a *Mechanical Paradox*, and which is actuated by means of what many, as he obſerves, even good mechanics, would be ready to pronounce impoſſible, viz. That the teeth of one wheel taking equally deep into the teeth of three others, ſhould affect them in ſuch a manner, that in turning it any way round its axis, it ſhould turn one of them the *ſame way*, another the *contrary way*, and the third *no way at all*.

The ſolution of the paradox is given under the article MECHANICS; after which, our author proceeds to give the following account of its uſes. "This machine is ſo much of an orrery, as is ſufficient to ſhow the different lengths of days and nights, the viciſſitudes of the ſeaſons, the retrograde motion of the nodes of the moon's orbit, the direct motion of the apogeal point of her orbit, and the months in which the ſun and moon muſt be eclipſed.

"On the great immoveable plate A (ſee fig. 213.) are the months and days of the year, and the ſigns and degrees of the zodiac ſo placed, that when the annual index *h* is brought to any given day of the year, it will point to the degree of the ſign in which the ſun is on that day. This index is fixed to the moveable frame

BC,

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BC, and is carried round the immoveable plate with it, by means of the knob *n*. The carrying this frame and index round the immoveable plate, anſwers to the earth's annual motion round the ſun, and to the ſun's apparent motion round the ecliptic in a year.

" The central wheel D (being fixt on the axis *a*, which is fixt in the centre of the immoveable plate) turns the thick wheel E round its own axis by the motion of the frame: and the teeth of the wheel E take into the teeth of the three wheels F, G, H, whoſe axes turn within one another, like the axes of the hour, minute, and ſecond hands of a clock or watch, where the ſeconds are ſhown from the centre of the dial-plate.

" On the upper ends of theſe axes, are the round plates I, K, L; the plate I being on the axis of the wheel F, K on the axis of G, and L on the axis of H. So that which ever way theſe wheels are affected, their reſpective plates, and what they ſupport, muſt be affected in the ſame manner; each wheel and plate being independent of the others.

" The two upright wires M and N, are fixed into the plate I; and they ſupport the ſmall ecliptic OP, on which, in the machine, the ſigns and degrees of the ecliptic are marked. This plate alſo ſupports the ſmall terreſtrial globe *e* on its inclining axis *f*, which is fixed into the plate near the foot of the wire N. This axis inclines 23½ degrees from a right line, ſuppoſed to be perpendicular to the ſurface of the plate I, and alſo to the plane of the ſmall ecliptic OP which is parallel to that plate.

" On the earth *e* is the creſcent *g*, which goes more than half way round the earth, and ſtands perpendicular to the plane of the ſmall ecliptic OP, directly facing the ſun Z: Its uſe is to divide the enlightened half of the earth next the ſun from the other half which is then in the dark; ſo that it repreſents the boundary of light and darkneſs, and therefore ought to go quite round the earth; but cannot in a machine, becauſe in ſome poſitions the earth's axis would fall upon it. The earth may be freely turned round on its axis by hand, within the creſcent, which is ſupported by the crooked wire *w*, fixt to it, and into the upper plate of the moveable frame BC.

" In the plate K are fixed the two upright wires Ω and R: they ſupport the moon's inclined orbit ST in its nodes, which are the two oppoſite points of the moon's orbit where it interſects the ecliptic OP. The aſcending node is marked Ω, to which the deſcending node is oppoſite below *e*, but hid from view by the globe *e*. The half ☊ T *e* of this orbit is on the north-ſide of the ecliptic OP, and the other half *e* S ☊ is on the ſouth ſide of the ecliptic. The moon is not in this machine; but when ſhe is in either of the nodes of her orbit in the heavens, ſhe is then in the plane of the ecliptic: when ſhe is in T in her orbit, ſhe is in her greateſt north latitude; and when ſhe is at S, ſhe is in her greateſt ſouth latitude.

" In the plate L is fixed the crooked wire UU, which points downward to the ſmall ecliptic OP, and ſhows the motion of the moon's apogee therein, and its place at any given time.

" The ball Z repreſents the ſun, which is ſupported by the crooked wire XY, fixt into the upper plate of the frame at X. A ſtraight wire W proceeds from the ſun Z, and points always toward the centre of the earth *e*; but toward different points of its ſurface at different times of the year, on account of the obliquity of its axis, which keeps its paralleliſm during the earth's annual courſe round the ſun Z; and therefore muſt incline ſometimes toward the ſun, at other times from him, and twice in the year neither toward nor from the ſun, but ſidewiſe to him. The wire W is called *the ſolar ray*.

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" As the annual-index *h* ſhows the ſun's place in the ecliptic for every day of the year, by turning the frame round the axis of the immoveable plate A, according to the order of the months and ſigns, the ſolar ray does the ſame in the ſmall ecliptic OP: for as this ecliptic has no motion on its axis, its ſigns and degrees ſtill keep parallel to thoſe on the immoveable plate. At the ſame time, the nodes of the moon's orbit ST (or points where it interſects the ecliptic OP) are moved backward, or contrary to the order of ſigns, at the rate of 19½ degrees every Julian year; and the moon's apogeal wire UU is moved forward, or according to the order of the ſigns of the ecliptic, nearly at the rate of 41 degrees every Julian year; the year being denoted by a revolution of the earth *e* round the ſun Z; in which time the annual-index *h* goes round the circles of months and ſigns on the immoveable plate A.

" Take hold of the knob *n*, and turn the frame round thereby; and in doing this, you will perceive that the north pole of the earth *e* is conſtantly before the creſcent *g*, in the enlightened part of the earth toward the ſun, from the 20th of March to the 23d of September; and the ſouth pole all that time behind the creſcent in the dark; and from the 23d of September to the 20th of March, the north pole is conſtantly in the dark behind the creſcent, and the ſouth pole in the light before it; which ſhows, that there is but one day and one night at each pole, in the whole year; and that when it is day at either pole, it is night at the other.

" From the 20th of March to the 23d of September, the days are longer than the nights in all thoſe places of the northern hemiſphere of the earth which revolve through the light and dark, and ſhorter in thoſe of the ſouthern hemiſphere. From the 23d of September to the 20th of March the reverſe.

" There are 24 meridian ſemicircles drawn on the globe, all meeting in its poles; and as one rotation or turn of the earth on its axis is performed in 24 hours, each of theſe meridians is an hour diſtant from the other, in every parallel of latitude. Therefore, if you bring the annual-index *h* to any given day of the year, on the immoveable plate, you may ſee how long the day then is at any place of the earth, by counting how many of theſe meridians are in the light, or before the creſcent, in the parallel of latitude of that place; and this number being ſubtracted from 24 hours, will leave remaining the length of the night. And if you turn the earth round its axis, all thoſe places will paſs directly under the point of the ſolar ray, which the ſun paſſes vertically over on that day, becauſe they are juſt as many degrees north or ſouth of the equator as the ſun's declination is then from the equinoctial.

" At the two equinoxes, viz. on the 20th of March and 23d of September, the ſun is in the equinoctial, and

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and conſequently has no declination. On theſe days, the ſolar ray points directly toward the equator, the earth's poles lie under the inner edge of the creſcent, or boundary of light and darkneſs; and in every parallel of latitude there are 12 of the meridians or hour circles before the creſcent, and 12 behind it; which ſhows that the days and nights then are each 12 hours long at all places of the earth. And if the earth be turned round its axis, you will ſee that all places on it go equally through the light and the dark hemiſpheres.

"On the 21ſt of of June, the whole ſpace within the north polar circle is enlightened, which is 23½ degrees from the pole, all around; becauſe the earth's axis then inclines 23½ degrees toward the ſun: but the whole ſpace within the ſouth polar circle is in the dark; and the ſolar ray points toward the tropic of Cancer on the earth, which is 23½ degrees north from the equator. On the 20th of December the reverſe happens, and the ſolar ray points toward the tropic of Capricorn, which is 23½ degrees ſouth from the equator.

"If you bring the annual-index *h* to the beginning of January, and turn the moon's orbit ST by its ſupporting wires Q and R till the aſcending node (marked ☊) comes to its place in the ecliptic OP, as found by an ephemeris, or by aſtronomical tables, for the beginning of any given year; and then move the annual-index by means of the knob *n*, till the index comes to any given day of the year afterward, the nodes will ſtand againſt their places in the ecliptic on that day; and if you move on the index till either of the nodes comes directly againſt the point of the ſolar ray, the index will then be at the day of the year on which the ſun is in the conjunction with that node. At the times of thoſe new moons which happen within ſeventeen days of the conjunction of the ſun with either of the nodes, the ſun will be eclipſed: and at the times of thoſe full moons, which happen within twelve days of either of theſe conjunctions, the moon will be eclipſed. Without theſe limits there can be no eclipſes either of the ſun or moon; becauſe, in nature, the moon's latitude or declination from the ecliptic is too great for the moon's ſhadow to fall on any part of the earth, or for the earth's ſhadow to touch the moon.

"Bring the annual-index to the beginning of January, and ſet the moon's apogeal wire UU to its place in the ecliptic for that time, as found by aſtronomical tables; then move the index forward to any given day of the year, and the wire will point on the ſmall ecliptic to the place of the moon's apogee for that time.

"The earth's axis *ſ* inclines always toward the beginning of the ſign Cancer on the ſmall ecliptic OP. And if you ſet either of the moon's nodes, and her apogeal wire to the beginning of that ſign, and turn the plate A about, until the earth's axis inclines toward any ſide of the room (ſuppoſe the north ſide), and then move the annual-index round and round the immoveable plate A, according to the order of the months and ſigns upon it, you will ſee that the earth's axis and beginning of Cancer will ſtill keep toward the ſame ſide of the room, without the leaſt deviation from it; but the nodes of the moon's orbit ST will turn progreſſively towards all the ſides of the room, contrary to the order of ſigns in the ſmall ecliptic OP, or from eaſt, by ſouth, to weſt, and ſo on; and the apogeal wire UU, will turn the contrary way to the motion of the nodes, or according to the order of the ſigns in the ſmall ecliptic, from weſt, by ſouth, to eaſt, and ſo on quite round. A clear proof that the wheel F, which governs the earth's axis and the ſmall ecliptic, does not turn any way round its own centre; that the wheel G, which governs the moon's orbit OP, turns round its own centre backward, or contrary both to the motion of the frame BC and thick wheel E; and that the wheel H, which governs the moon's apogeal wire UU, turns round its own centre forward, or in direction both of the motion of the frame and of the thick wheel E, by which the three wheels F, G, and H, are affected.

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The wheels D, E, and F, have each 39 teeth in the machine; the wheel G has 37, and H 44.

"The parallelism of the earth's axis is perfect in this machine; the motion of the apogee very nearly ſo; the motion of the nodes not quite ſo near the truth, though they will not vary ſenſibly therefrom in one year. But they cannot be brought nearer, unleſs larger wheels, with higher numbers of teeth, are uſed.

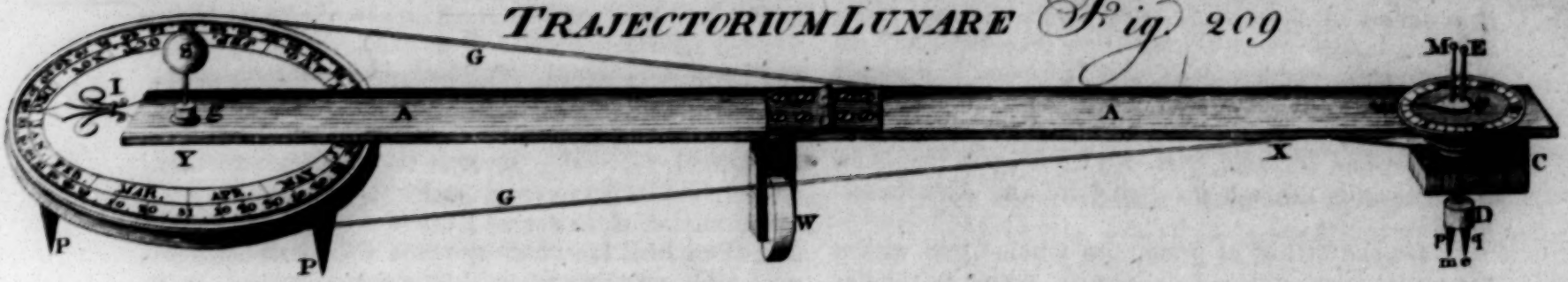
In nature, the moon's apogee goes quite round the ecliptic in eight years and 312 days, in direction of the earth's annual motion; and the nodes go round the ecliptic, in a contrary direction, in 18 years and 225 days. In the machine, the apogee goes round the ecliptic OP in eight years and four-fifths of a year, and the nodes in eighteen years and a half."

The Cometarium, (fig. 216.) This curious machine ſhows the motion of a comet or eccentric body moving round the ſun, deſcribing equal areas in equal times, and may be ſo contrived as to ſhow ſuch a motion for any degree of eccentricity. It was invented by the late Dr Deſaguliers. 492

The dark elliptical groove round the letters *a b c d e f g h i k l m* is the orbit of the comet Y; this comet is carried round in the groove according to the order of letters, by the wire W fixed in the ſun S, and ſlides on the wire as it approaches nearer to or recedes farther from the ſun, being neareſt of all in the perihelion *a*, and fartheſt in the aphelion *g*. The areas, *a* S *b*, *b* S *c*, *c* S *d*, &c. or contents of theſe ſeveral triangles, are all equal; and in every turn of the winch N, the comet Y is carried over one of theſe areas; conſequently, in as much time as it moves from *f* to *g*, or from *g* to *b*, it moves from *m* to *a*, or from *a* to *b*; and ſo of the reſt, being quickeſt of all at *a*, and ſloweſt at *g*. Thus the comet's velocity in its orbit continually decreaſes from the perihelion *a* to the aphelion *g*; and increaſes in the ſame proportion from *g* to *a*.

The elliptic orbit is divided into 12 equal parts or ſigns, with their reſpective degrees, and ſo is the circle *n o p q r s t u*, which repreſents a great circle in the heavens, and to which the comet's motion is referred by a ſmall knob on the point of the wire W. Whilſt the comet moves from *f* to *g* in its orbit, it appears to move only about five degrees in this circle, as is ſhown by the ſmall knob on the end of the wire W; but in as ſhort time as the comet moves from *m* to *a*, or from *a* to *b*, it appears to deſcribe the large ſpace *t n* or *n o* in the heavens, either of which ſpaces contains

TRAJECTORIUM LUNARE Fig. 209



PLANETARIUM by Jones

Fig. 210

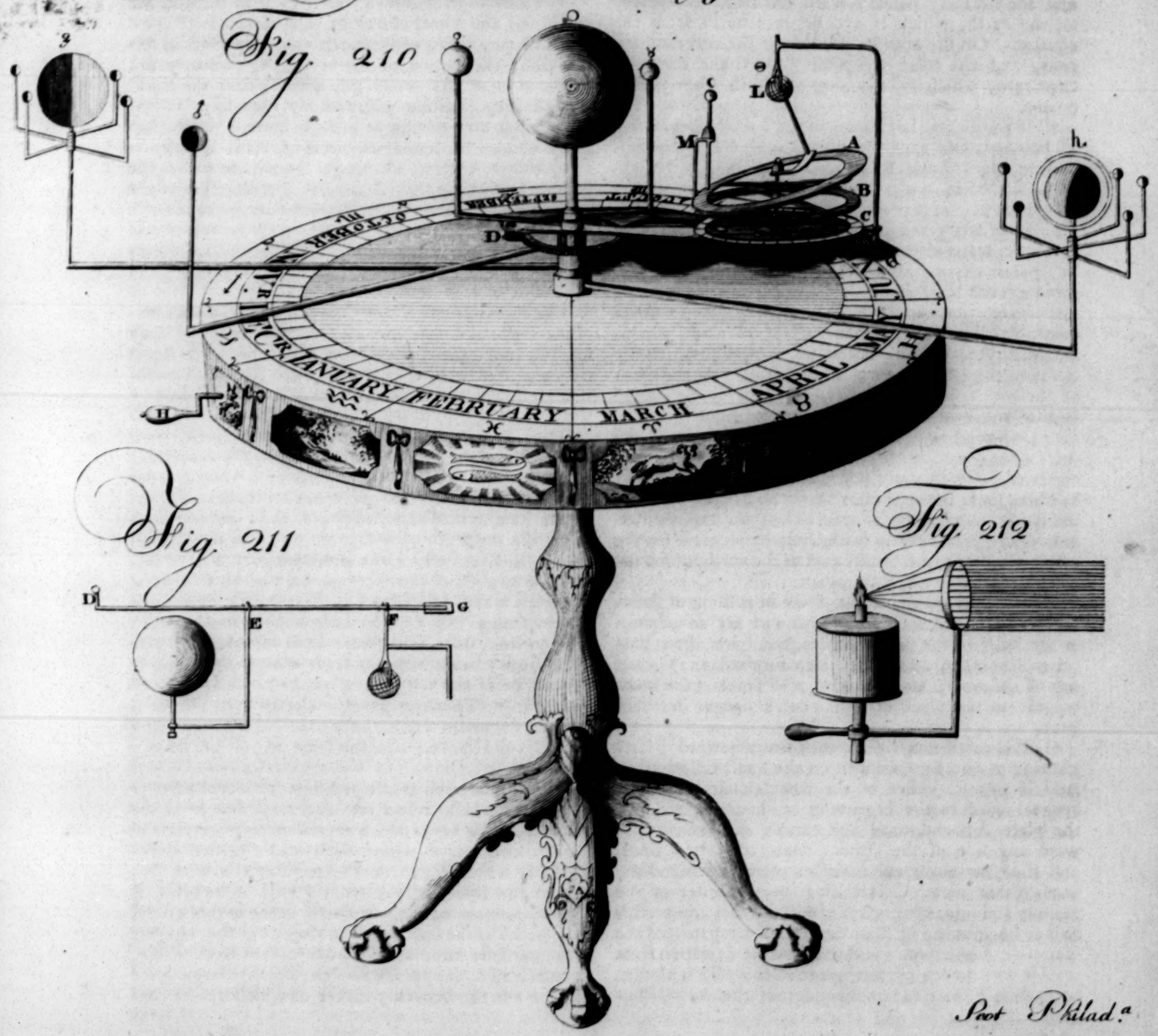


Fig. 211

Fig. 212

Scot Philad.a

BRITISH MUSEUM

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tains 120 degrees, or four signs. Were the eccentricity of its orbit greater, the greater ſtill would be the difference of its motion, and *vice verſa*.

ABCDEFGHIKLM is a circular orbit for ſhowing the equable motion of a body round the ſun S, deſcribing equal areas ASB, BSC, &c. in equal times with thoſe of the body Y in its elliptical orbit abovementioned; but with this difference, that the circular motion deſcribes the equal arcs AB, BC, &c. in the ſame equal times that the elliptical motion deſcribes the unequal arcs, *a b*, *bc*, &c.

Now, ſuppoſe the two bodies Y and I to ſtart from the points *a* and A at the ſame moment of time, and, each having gone round its reſpective orbit, to arrive at theſe points again at the ſame inſtant, the body Y will be forwarder in its orbit than the body I all the way from *a* to *g*, and from A to G: but I will be forwarder than Y through all the other half of the orbit; and the difference is equal to the equation of the body Y in its orbit. At the points *a* A, and *g* G, that is, that in the perihelion and aphelion they will be equal; and then the equation vaniſhes. This ſhows why the equation of a body moving in an elliptic orbit, is added to the mean or ſuppoſed circular motion from the perihelion to the aphelion, and ſubtracted from the aphelion to the perihelion, in bodies moving round the ſun, or from the perigee to the apogee, and from the apogee to the perigee in the moon's motion round the earth.

This motion is performed in the following manner by the machine, fig. 217. ABC is a wooden bar (in the box containing the wheel-work), above which are the wheels D and E, and below it the elliptic plates FF and GG; each plate being fixed on an axis in one of its focuſes, at E and K: and the wheel E is fixed on the ſame axis with the plate FF. Theſe plates have grooves round their edges preciſely of equal diameters to one another, and in theſe grooves is the cat-gut ſtring *g g*, *g g* croſſing between the plates at *h*. On H, the axis of the handle or winch N in fig. 216, is an endleſs ſcrew in fig. 217. working in the wheels D and E, whoſe numbers of teeth being equal, and ſhould be equal to the number of lines *a* S, *b* S, *c* S, &c. in fig. 216, they turn round their axes in equal times to one another, and to the motion of the elliptic plates. For, the wheels D and E having equal numbers of teeth, the plate FF being fixed on the ſame axis with the wheel E, and turning the equally big plate GG by a cat-gut ſtring round them both, they muſt all go round their axes in as many turns of the handle N as either of the wheels has teeth.

It is eaſy to ſee, that the end of *h* of the elliptical plate FF being farther from its axis E than the oppoſite end I is, muſt deſcribe a circle ſo much the larger in proportion, and therefore move through ſo much more ſpace in the ſame time; and for that reaſon the end *h* moves ſo much faſter than the end I, although it goes no ſooner round the centre E. But then the quick-moving end *h* of the plate FF leads about the ſhort end *h* K of the plate GG with the ſame velocity; and the ſlow-moving end I of the plate FF coming half round as to B, muſt then lead the long end *k* of the plate GG as ſlowly about: ſo that the elliptical plate FF and its axis E move uniformly and equally quick in every part of its revolution; but the elliptical plate GG, together with its axis K, muſt move very unequally in different parts of its revolution; the difference being always inverſely as the diſtance of any point of the circumference of GG from its axis at K: or in other words, to inſtance in two points, if the diſtance K *k* be four, five, or ſix times as great as the diſtance K *h*, the point *h* will move in that poſition, four, five, or ſix times as faſt as the point *k* does, when the plate GG has gone half round; and ſo on for any other eccentricity or difference of the diſtances K *k* and K *h*. The tooth I on the plate FF falls in between the two teeth at *k* on the plate GG; by which means the revolution of the latter is ſo adjuſted to that of the former, that they can never vary from one another.

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On the top of the axis of the equally moving-wheel D in fig. 217. is the ſun S in fig. 216.; which ſun, by the wire fixed to it, carries the ball I round the circle ABCD, &c. with an equable motion, according to the order of the letters: and on the top of the axis K of the unequally-moving ellipſis GG, in fig. 217. is the ſun S in fig. 216. carrying the ball Y unequally round in the elliptical groove *a b c d*, &c. *N. B.* This elliptical groove muſt be preciſely equal and ſimilar to the verge of the plate GG, which is alſo equal to that of FF.

In this manner machines may be made to ſhow the true motion of the moon about the earth, or of any planet about the ſun, by making the elliptical plates of the ſame eccentricities, in proportion to the radius, as the orbits of the planets are, whoſe motions they repreſent; and ſo their different equations in different parts of their orbits may be made plain to ſight, and clearer ideas of theſe motions and equations acquired in half an hour, than could be gained from reading half a day about ſuch motions and equations.

The IMPROVED CELESTIAL GLOBE, fig. 187. On 493
the north pole of the axis, above the hour-circle, is fixed an arch MKH of 23½ degrees; and at the end H is fixed an upright pin HG, which ſtands directly over the north pole of the ecliptic, and perpendicular to that part of the ſurface of the globe. On this pin are two moveable collets at D and H, to which are fixed the quadrantile wires N and O, having two little balls on their ends for the ſun and moon, as in the figure. The collet D is fixed to the circular plate F, whereon the 29½ days of the moon's age are engraven, beginning juſt under the ſun's wire N; and as this wire is moved round the globe, the plate F turns round with it. Theſe wires are eaſily turned, if the ſcrew G be ſlackened: and when they are ſet to their proper places, the ſcrew ſerves to fix them there, ſo as in turning the ball of the globe, the wires with the ſun and moon go round with it; and theſe two little balls riſe and ſet at the ſame times, and on the ſame points of the horizon, for the day to which they are rectified, as the ſoon and moon do in the heavens.

Becauſe the moon keeps not her courſe in the ecliptic (as the ſun appears to do), but has a declination of 5½ degrees on each ſide from it in every lunation, her ball may be ſcrewed as many degrees to either ſide of the ecliptic as her latitude or declination from the ecliptic amounts to at any given time.

The horizon is ſupported by two ſemicircular arches, becauſe pillars would ſtop the progreſs of the

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balls when they go below the horizon in an oblique ſphere.

To rectify this globe. Elevate the pole to the latitude of the place; then bring the ſun's place in the ecliptic for the given day to the brazen meridian, and ſet the hour-index to 12 at noon, that is, to the upper 12 on the hour-circle; keeping the globe in that ſituation, ſlacken the ſcrew G, and ſet the ſun directly over his place on the meridian; which done ſet the moon's wire under the number that expreſſes her age for that day on the plate F, and ſhe will then ſtand over her place in the ecliptic, and ſhow what conſtellation ſhe is in. Laſtly, faſten the ſcrew G, and adjuſt the moon to her latitude, and the globe will be rectified.

Having thus rectified the globe, turn it round, and obſerve on what points of the horizon the ſun and moon balls riſe and ſet, for theſe agree with the points of the compaſs on which the ſun and moon riſe and ſet in the heavens on the given day: and the hour-index ſhows the times of their riſing and ſetting; and likewiſe the time of the moon's paſſing over the meridian.

This ſimple apparatus ſhows all the varieties that can happen in the riſing and ſetting of the ſun and moon: and makes the forementioned phenomena of the harveſt moon plain to the eye. It is alſo very uſeful in reading lectures on the globes, becauſe a large company can ſee this ſun and moon go round, riſing above and ſetting below the horizon at different times, according to the ſeaſons of the year; and making their appulſes to different fixed ſtars. But in the uſual way, where there is only the places of the ſun and moon in the ecliptic to keep the eye upon, they are eaſily loſt ſight of, unleſs they be covered with patches.

494 The Trajectorium Lunare, fig. 208. This machine is for delineating the paths of the earth and moon, ſhowing what ſort of curves they make in the etherial regions. S is the ſun, and E the earth, whoſe centres are 95 inches diſtant from each other; every inch anſwering to 1,000,000 of miles. M is the moon, whoſe centre is $\frac{4}{10}$ parts of an inch from the earth's in this machine, this being in juſt proportion to the moon's diſtance from the earth. AA is a bar of wood, to be moved by hand round the axis *g* which is fixed in the wheel Y. The circumference of this wheel is to the circumference of the ſmall wheel L (below the other end of the bar) as 365¼ days is to 29½, or as a year is to a lunation. The wheels are grooved round their edges, and in the grooves is the cat-gut ſtring GG croſſing between the wheels at X. On the axis of the wheel L is the index F, in which is fixed the moon's axis M for carrying her round the earth E (fixed on the axis of the wheel L in the time that the index goes round a circle of 29½ equal parts, which are the days of the moon's age. The wheel Y has the months and days of the year all round its limb; and in the bar AA is fixed the index *I*, which points out the days of the months anſwering to the days of the moon's age, ſhown by the index F, in the circle of 29½ equal parts at the other end of the bar. On the axis of the wheel L is put the piece D, below the cock C, in which this axis turns round; and in D are put the pencils *e* and *m* directly under the earth E and moon M; ſo that *m* is carried round *e* as M is round E

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Lay the machine on an even floor, preſſing gently on the wheel Y, to cauſe its ſpiked feet (of which two appear at P and P, the third being ſuppoſed to be hid from ſight by the wheel) enter a little into the floor to ſecure the wheel from turning. Then lay a paper about four feet long under the pencils *e* and *m*, croſswiſe to the bar; which done, move the bar ſlowly round the axis *g* of the wheel Y; and as the earth E goes round the ſun S, the moon M will go round the earth with a duly proportioned velocity; and the friction wheel W running on the floor, will keep the bar from bearing too heavily on the pencils *e* and *m*, which will delineate the paths of the earth and moon. As the index I points out the days of the months, the index F ſhows the moon's age on theſe days, in the circle of 29½ equal parts. And as this laſt index points to the different days in its circle, the like numeral figures may be ſet to thoſe parts of the curves of the earth's path and moon's, where the pencils *e* and *m* are at thoſe times reſpectively, to ſhow the places of the earth and moon. If the pencil *e* be puſhed a very little off, as if from the pencil *m*, to about $\frac{1}{14}$ part of their diſtance, and the pencil *m* puſhed as much towards *e*, to bring them to the ſame diſtances again, though not to the ſame points of ſpace; then, as *m* goes round *e*, *e* will go as it were round the centre of gravity between the earth *e* and moon *m*; but this motion will not ſenſibly alter the figure of the earth's path or the moon's.

If a pin, as *p*, be put through the pencil *m*, with its head, towards that of the pin *q* in the pencil *e*, its head will always keep thereto as *m* goes round *e*, or as the ſame ſide of the moon is ſtill obverted to the earth. But the pin *p*, which may be conſidered as an equatorial diameter of the moon, will turn quite round the point *m*, making all poſſible angles with the line of its progreſs, or line of the moon's path. This is an occular proof of the moon's turning round her axis.

Sect. XIII. *A Deſcription of the principal aſtronomical Inſtruments by which Aſtronomers make their moſt accurate Obſervations.*

By practical aſtronomy is implied the knowledge 495
of obſerving the celeſtial bodies with reſpect to their poſition and time of the year, and of deducing from thoſe obſervations certain concluſions uſeful in calculating the time when any propoſed poſition of theſe bodies ſhall happen.

For this purpoſe, it is neceſſary to have a room or place conveniently ſituated, ſuitably contrived, and furniſhed with proper aſtronomical inſtruments. It ſhould have an uninterrupted view from the zenith down to (or even below) the horizon, at leaſt towards its cardinal points: and for this purpoſe, that part of the roof which lies in the direction of the meridian in particular, ſhould have moveable covers, which may eaſily be moved and put on again; by which means an inſtrument may be directed to any point of the heavens between the horizon and the zenith, as well to the northward as ſouthward.

This place, called an Obſervatory, ſhould contain ſome, if not all, of the following inſtruments.

I. A Pendulum Clock, for ſhowing equal time. 496
This

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This ſhould ſhow time in hours, minutes, and ſeconds; and with which the obſerver, by hearing the beats of the pendulum, may count them by his ear, while his eye is employed on the motion of the celeſtial object he is obſerving. Juſt before the object arrives at the poſition deſcribed, the obſerver ſhould look on the clock and remark the time, ſuppoſe it 9 hours 15 minutes 25 ſeconds; then ſaying, 25, 26, 27, 28, &c. reſponſive to the beat of the pendulum, till he ſees through the inſtrument the object arrived at the poſition expected; which ſuppoſe to happen when he ſays 38, he then writes down 9 h. 15 min. 38 ſec. for the time of obſervation, annexing the year and the day of the month. If two perſons are concerned in making the obſervation, one may read the time audibly while the other obſerves through the inſtrument, the obſerver repeating the laſt ſecond read when the deſired poſition happens.

II. An ACHROMATIC REFRACTING TELESCOPE, or a REFLECTING one, of two feet at leaſt in length, for obſerving particular phenomena. Theſe inſtruments are particularly deſcribed under OPTICS.

III. A MICROMETER, for meaſuring ſmall angular diſtances. See MICROMETER.

IV. ASTRONOMICAL QUADRANTS, both mural and portable, for obſerving meridian and other altitudes of the celeſtial bodies.

497 1. The *Mural Quadrant* is in the form of a quarter of a circle, contained under two radii at right angles to one another, and an arch equal to one-fourth part of the circumference of the circle. It is the moſt uſeful and valuable of all the aſtronomical inſtruments; and as it is ſometimes fixed to the ſide of a ſtone or brick wall, and the plane of it erected exactly in the plane of the meridian, it in this caſe receives the name of *mural quadrant or arch*.

Tycho Brache was the firſt perſon who contrived this mural arch, viz who firſt applied it to a wall; and Mr Flamſtead, the firſt in England who with indefatigable pains fixed one up in the royal obſervatory at Greenwich.

Theſe inſtruments have uſually been made from five to eight feet radius, and executed by thoſe late celebrated artiſts, Siſſon, Graham, Bird, and other eminent mathematical inſtrument makers now in London. The conſtruction of them being generally the ſame in all the ſizes, we ſhall here deſcribe one made by the late Jon. Siſſon, under the direction of the late M. Graham. Fig. 214. repreſents the inſtrument as already fixed to the wall. It is of copper, and of about 5 feet radius. The frame is formed of flat bars, and ſtrengthened by edge bars affixed underneath perpendidicularly to them. The radii HB, HA, being divided each into four equal parts, ſerve to find out the points D and E, by which the quadrant is freely ſuſpended on its props or iron ſupports that are faſtened ſecurely in the wall.

One of the ſupports E is repreſented ſeparately in *e* on one ſide of the quadrant. It is moveable by means of a long ſlender rod EF or *ef*, which goes into a hollow ſcrew in order to reſtore the inſtrument to its ſituation when it is diſcovered to be a little deranged. This may be known by the very fine perpendicular thread HA, which ought always to coincide with the ſame point A of the limb, and carefully examined to be ſo by a ſmall magnifying teleſcope at every obſervation. In order to prevent the unſteadineſs of ſo great a machine, there ſhould be placed behind the limb four copper ears with double cocks I, K, I, K. There are others along the radii HA and HB. Each of theſe cocks contains two ſcrews, into which is faſtened the ears that are fixed behind the quadrant.

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Over the wall or ſtone which ſupports the inſtrument, and at the ſame height as the centre is placed horizontally the axis PO, which is perpendicular to the plane of the inſtrument, and which would paſs through the centre if it was continued. This axis turns on two pivots P. On this axis is fixed at right angles another branch ON, loaded at its extremity with a weight N capable of equipoiſing with its weight that of the teleſcope LM; whilſt the axis, by its extremity neareſt the quadrant, carries the wooden frame PRM, which is faſtened to the teleſcope in M. The counterpoiſe takes off from the obſerver the weight of the teleſcope when he raiſes it, and hinders him from either forcing or ſtraining the inſtrument.

The lower extremity (V) of the teleſcope is furniſhed with two ſmall wheels, which take the limb of the quadrant on its two ſides. The teleſcope hardly bears any more upon the limb than the ſmall friction of theſe two wheels; which renders its motion ſo extremely eaſy and pleaſant, that by giving it with the hand only a ſmall motion, the teleſcope will run of itſelf over a great part of the limb, balanced by the counterpoiſe N.

When the teleſcope is to be ſtopped at a certain poſition, the copper hand T is to be made uſe of, which embraces the limb and ſprings at the bottom. It is fixed by ſetting a ſcrew, which faſtens it to the limb. Then, in turning the regulating ſcrew, the teleſcope will be advanced; which is continued until the ſtar or other object whoſe altitude is obſerving to be on the horizontal fine thread in the teleſcope. Then on the plate X ſupporting the teleſcope, and carrying a vernier or nonius, will be ſeen the number of degrees and minutes, and even quarter of minutes, that the angular height of the object obſerved is equal to. The remainder is eaſily eſtimated within two or three ſeconds nearly.

There are ſeveral methods of ſubdividing the diviſions of a mural quadrant, which are uſually from five to ten minutes each; but that which is moſt commonly adopted is by the vernier or nonius, the contrivance of Peter Vernier a Frenchman. This vernier conſiſts of a piece of copper or braſs, CDAB (fig. 215.), which is a ſmall portion of X (fig. 214.), repreſented ſeparately. The length CD is divided into 20 equal parts, and placed contiguouſly on a portion of the diviſion of the limb of the quadrant containing 21 diviſions, and thereby dividing this length into 20 equal parts. Thus the firſt diviſion of the vernier piece marked 15, beginning at the point D, is a little matter backward, or to the left of the firſt diviſion of the limb, equal to $15''$. The ſecond diviſion of the vernier is to the left of the ſecond diviſion of the limb double of the firſt difference, or $30''$; and ſo on unto the twentieth and laſt diviſion on the left of the vernier piece; where the 20 differences being accumulated each of the twentieth part of the diviſion of the limb, this laſt diviſion will

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be found to agree exactly with the 21ſt diviſion on the limb of the quadrant.

The index muſt be puſhed the 20th part of a diviſion, or 15″, to the right; for to make the ſecond diviſion on the vernier coincide with one of the diviſions of the limb, in like manner is moving two-twentieths, or 30″, we muſt look at the ſecond diviſion of the index, and there will be a coincidence with a diviſion of the limb. Thus may be conceived that the beginning D of the Vernier, which is always the line of reckoning, has advanced two diviſions, or 30″, to the right, when the ſecond diviſion, marked 30 on the vernier, is ſeen to correſpond exactly with one of the lines of the quadrant.

By means of this vernier may be readily diſtinguiſhed the exactitude of 15″ of the limb of a quadrant five feet radius, and ſimply divided into 5′. By an eſtimation by the eye, afterwards the accuracy of two or three ſeconds may be eaſily judged. On the ſide of the quadrant is placed the plate of copper which carries the teleſcope. This plate carries two verniers. The outer line CD divides five minutes into 20 parts, or 15″ each. The interior line AB anſwers to the parts of another diviſion not having 90°, but 96 parts of the quadrant. It is uſually adopted by Engliſh aſtronomers on account of the facility of its ſubdiviſions. Each of the 96 portions of the quadrant is equivalent to 56′ 15″ of the uſual diviſions. It is divided on the limb into 16 parts, and the arch of the vernier AB contains 25 of theſe diviſions; and being divided itſelf into 24, immediately gives parts, the value of each of which is $8'' \; 47\frac{1}{2}'''$. From this mode a table of reduction may eaſily be conſtructed, which will ſerve to find the value of this ſecond mode of dividing in degrees, minutes, and ſeconds, reckoning in the uſual manner, and to have even the advantage of two different modes; which makes an excellent verification of the diviſions on the limb of the quadrant and obſerved heights by the vernier.

498 2. *The Portable Aſtronomical Quadrant*, is that inſtrument of all others which aſtronomers make the greateſt uſe of, and have the moſt eſteem for. They are generally made from 12 to 23 inches. Fig. 219. is a repreſentation of the improved modern one as made by the late Mr Siſſon and by the preſent mathematical inſtrument makers. This is capable of being carried to any part of the world, and put up for obſervation in an eaſy and accurate manner. It is made of braſs, and ſtrongly framed together by croſſed perpendicular bars. The arch AC, and the teleſcope EF, are divided and conſtructed in a ſimilar manner to the mural quadrant, but generally without the diviſion of 96 parts. The counterpoiſe to the teleſcope T is repreſented at P, and alſo another counterpoiſe to the quadrant itſelf at P. The quadrant is fixed to a long axis, which goes into the pillar KR. Upon this axis is fixed an index, which points to, and ſubdivides by a vernier the diviſions of the azimuth circle K. This azimuth circle is extremely uſeful for taking the azimuth of a celeſtial body at the ſame time its altitude is obſerved. The upper end of the axis is firmly connected with the adjuſting frame GH; and the pillar is ſupported on the croſſed feet at the bottom of the pillar KR with the adjuſting ſcrews *a*, *b*, *c*, *d*.

When this inſtrument is ſet up for uſe or obſervation, it is neceſſary that two adjuſtments be very accurately made: One, that the plane or ſurface of the inſtrument be truly perpendicular to the horizon; the other that the line ſuppoſed to be drawn from the centre to the firſt line of the limb, be truly on a level or parallel with the horizon. The firſt of theſe particulars is done by means of the thread and plummet *p*; the thread of which is uſually of very fine ſilver wire, and it is placed oppoſite to a mark made upon the end of the limb of the inſtrument. The four ſcrews at the foot, *a*, *b*, *c*, *d*, are to be turned until a perfect coincidence is obſerved of the thread upon the mark, which is accurately obſerved by means of a ſmall teleſcope T, that fits on the limb. The other adjuſtment is effected by means of the ſpirit-level L, which applies on the frame GH, and the ſmall ſcrews turned as before until the bubble of air in the level ſettles in the middle of the tube. The dotted tube EB is a kind of prover to the inſtrument; for by obſerving at what mark the centre of it appears againſt, or by putting up a mark againſt it, it will at any time diſcover if the inſtrument has been diſplaced. The ſcrew S at the index, is the regulating or adjuſting ſcrew, to move the teleſcope and index, during the obſervation, with the utmoſt nicety.

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V. Aſtronomical *or* Equatorial Sector. 499

This is an inſtrument for finding the difference in right aſcenſion and declination between two objects, the diſtance of which is too great to be obſerved by the micrometer. It was the invention of the late ingenious Mr George Graham, F. R. S. and is conſtructed from the following particulars. Let AB (fig. 32.) repreſent an arch of a circle containing 10 or 12 degrees well divided, having a ſtrong plate CD for its radius, fixed to the middle of the arch at D: let this radius be applied to the ſide of an axis H F I, and be moveable about a joint fixed to it at F, ſo that the plane of the ſector may be always parallel to the axis HI; which being parallel to the axis of the earth, the plane of the ſector will always be parallel to the plane of ſome hour-circle. Let a teleſcope CE be moveable about the centre C of the arch AB, from one end of it to the other, by turning a ſcrew at G; and let the line of ſight be parallel to the plane of the ſector. Now, by turning the whole inſtrument about the axis HI, till the plane of it be ſucceſſively directed, firſt to one of the ſtars and then to another, it is eaſy to move the ſector about the joint F, into ſuch a poſition, that the arch AB, when fixed, ſhall take in both the ſtars in their paſſage, by the plane of it, provided the difference of the declinations does not exceed the arch AB. Then, having fixed the plane of the ſector a little to the weſtward of both the ſtars, move the teleſcope CE by the ſcrew G; and obſerve by a clock the time of each tranſit over the croſs hairs, and alſo the degrees and minutes upon the arch AB, cut by the index at each tranſit; then in the difference of the arches the difference of the declinations, and by the difference of the times, we have the difference of the right aſcenſions of the ſtars.

The dimenſions of this inſtrument are theſe: The length of the teleſcope, or the radius of the ſector, is $2\frac{1}{4}$ feet; the breadth of the radius, near the end C, is $1\frac{1}{4}$ inch; and at the end D two inches. The breadth of the limb AB is $1\frac{1}{4}$ inch; and its length

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Fig. 213.
Mechanical Paradox.

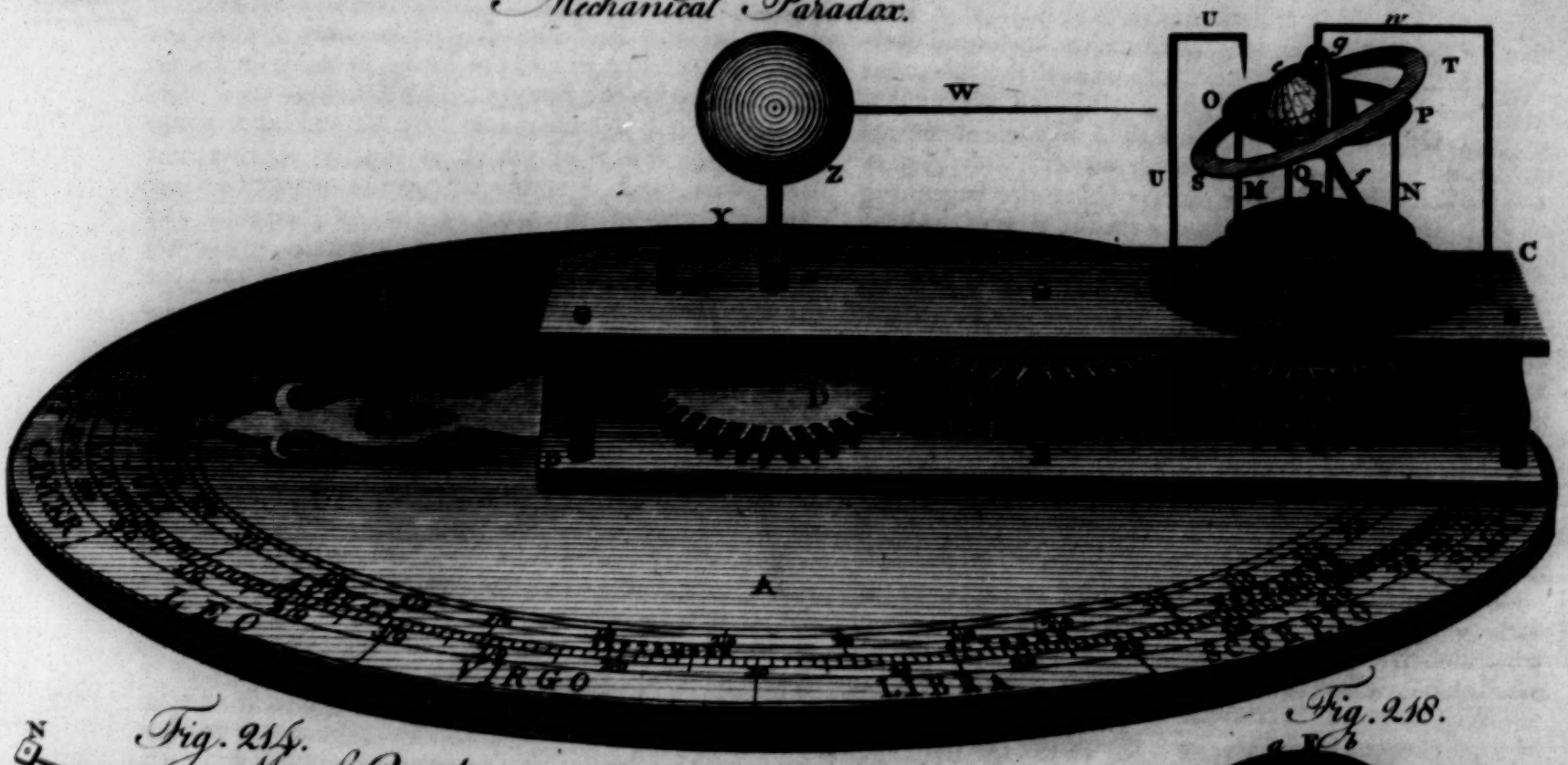

Fig. 214.
Mural Quadrant.

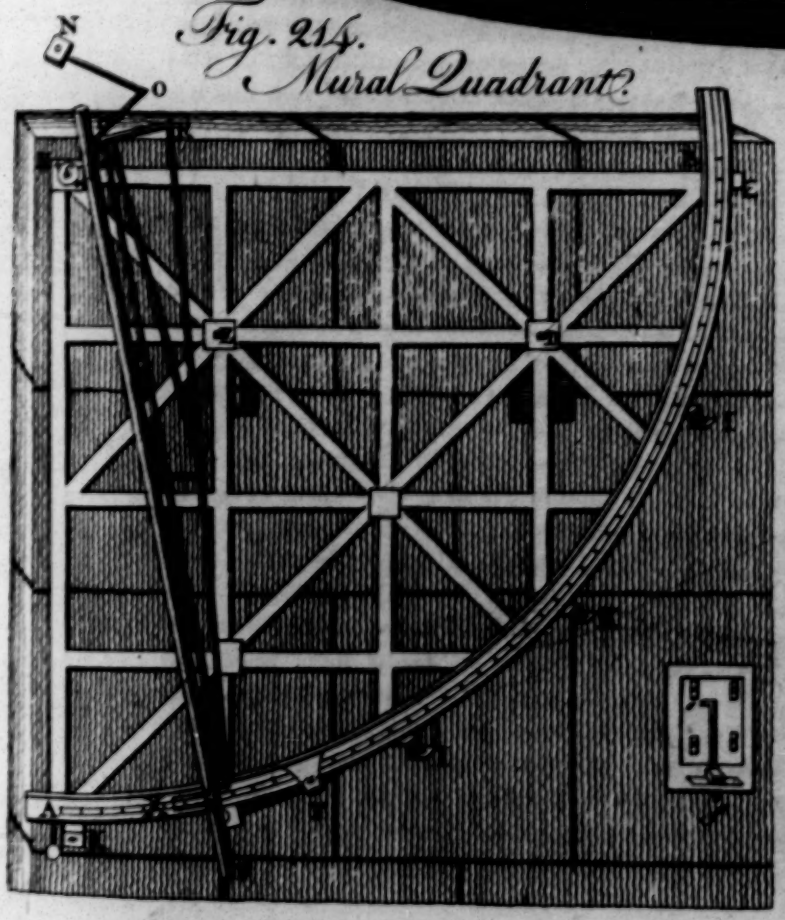

Fig. 215.

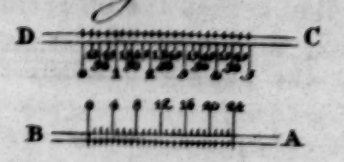

Fig. 216.
Cometarium.

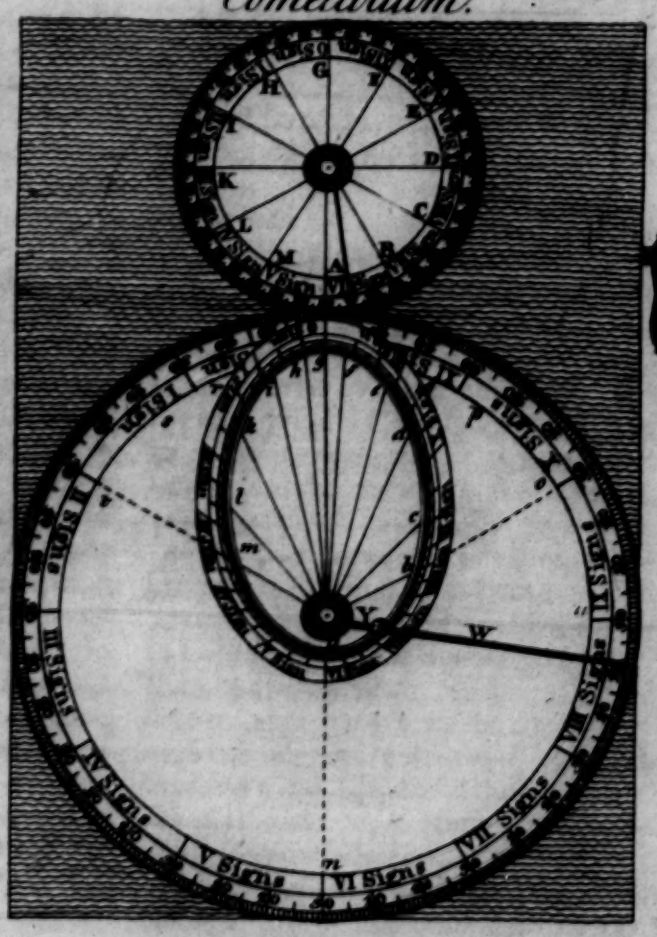

Fig. 217.

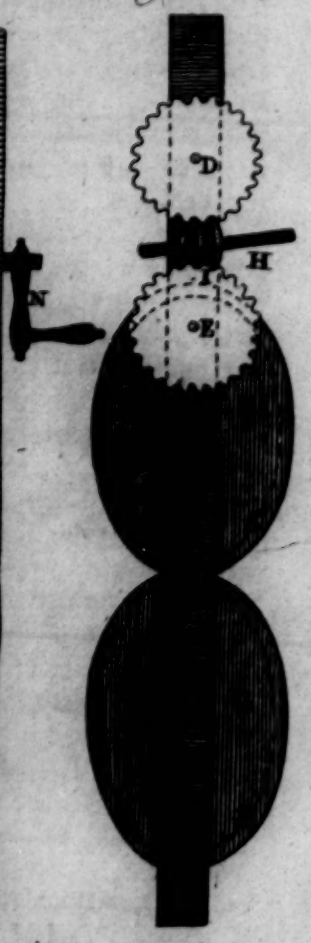

Fig. 218.

Thackara & Vallance Sculp.

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ſix inches, containing ten degrees divided into quarters and numbered from either end to the other. The teleſcope carries a nonius or ſubdividing plate, whoſe length, being equal to ſixteen quarters of a degree, is divided into fifteen equal parts; which, in effect, divides the limb into minutes, and, by eſtimation, into ſmaller parts. The length of the ſquare axis HIF is eighteen inches, and of the part HI twelve inches; and its thickneſs is about a quarter of an inch: the diameters of the circles are each five inches: the thickneſs of the plates, and the other meaſures, may be taken at the direction of a workman.

This inſtrument may be rectified, for making obſervations, in this manner: By placing the interſection of the croſs hairs at the ſame diſtance from the plane of the ſector, as the centre of the object-glaſs, the plane deſcribed by the line of ſight during the circular motion of the teleſcope upon the limb, will be ſufficiently true, or free from conical curvity; which may be examined by ſuſpending a long plumb-line at a convenient diſtance from the inſtrument; and by fixing the plane of the ſector in a vertical poſition, and then by obſerving, while the teleſcope is moved by the ſcrew along the limb, whether the croſs hairs appear to move along the plumb-line.

The axis *h f o* may be elevated nearly parallel to the axis of the earth, by means of a ſmall common quadrant; and its error may be corrected, by making the line of ſight follow the circular motion of any of the circumpolar ſtars, while the whole inſtrument is moved about its axis *h f o*, the teleſcope being fixed to the limb: for this purpoſe, let the teleſcope *k l* be directed to the ſtar *a*, when it paſſes over the higheſt point of its diurnal circle, and let the diviſion cut by the nonius be then noted; then, after twelve hours, when the ſtar comes to the loweſt point of its circle, having turned the inſtrument half round its axis, to bring the teleſcope into the poſition *m n*; if the croſs hairs cover the ſame ſtar ſuppoſed at *b*, the elevation of the axis *h f o* is exactly right; but if it be neceſſary to move the teleſcope into the poſition *u v*, in order to point to this ſtar at *c*, the arch *m u*, which meaſures the angle *m f u*, or *b f c*, will be known; and then the axis *h f o* muſt be depreſſed half the quantity of this given angle if the ſtar paſſed below *b*, or muſt be raiſed ſo much higher if above it; and then the trial muſt be repeated till the true elevation of the axis be obtained. By making the like obſervations upon the ſame ſtar on each ſide the pole, in the ſix-o'clock-hour-circle, the error of the axis, toward the eaſt or weſt may alſo be found and corrected, till the croſs hairs follow the ſtar quite-round the pole: for ſuppoſing *a o p b c* to be an arch of the meridian (or in the ſecond practice of the ſix-o'clock-hour-circle), make the angle *a f p* equal to half the angle *a f c*, and the line *f p* will point to the pole; and the angle *o f p*, which is the error of the axis, will be equal to half the angle *b f c* or *m f u*, found by the obſervation; becauſe the difference of the two angles *a f b*, *a f c*, is double the difference of their halves *a f o* and *a f p*. Unleſs the ſtar be very near the pole, allowance muſt be made by refractions.

VI. Transit and Equal Altitude Inſtruments.

500 1. *The Tranſit Inſtrument* is uſed for obſerving objects as they paſs over the meridian. It conſiſts of a teleſcope fixed at right angles to an horizontal axis; which axis muſt be ſupported that what is called the line of collimation, or line of ſight of the teleſcope, may move in the plane of the meridian. This inſtrument was firſt made by the celebrated Mr Romeur in the year 1689, and has ſince received great improvements. It is made of various ſizes, and of large dimenſions in our great obſervatories; but the following is one of a ſize ſufficiently large and accurate for all the uſeful purpoſes. Aſtronomical Inſtruments.

The axis AB (fig. 220.), to which the middle of the teleſcope is fixed, is about 2½ feet long, tapering gradually towards its ends, which terminate in cylinders well turned and ſmoothed. The teleſcope CD which is about four feet long and 1¼ inch diameter, is connected with the axis by means of a ſtrong cube or die G, and in which the two cones MQ, forming the axis are fixed. This cube or ſtock G ſerves as the principal part of the whole machine. It not only keeps together the two cones, but holds the two ſockets KH, of 15 inches length, for the two teleſcopic tubes. Each of theſe ſockets has a ſquare baſe, and is fixed to the cube by four ſcrews. Theſe ſockets are cut down in the ſides about eight inches, to admit more eaſily the tube of the teleſcope; but when the tube is inſerted, it is kept in firm by ſcrewing up the tightening ſcrews at the end of the ſockets at K and H. Theſe two ſockets are very uſeful in keeping the teleſcope in its greateſt poſſible degree of ſteadineſs. They alſo afford a better opportunity of balancing the teleſcope and rectifying its vertical thread, than by any other means.

In order to direct the teleſcope to the given height that a ſtar would be obſerved at, there is fixed a ſemicircle AN on one of the ſupporters, of about 8½ inches diameter, and divided into degrees. The index is fixed on the axis, at the end of which is a vernier, which ſubdivides the degrees into 12 parts or five minutes. This index is moveable on the axis, and may be cloſely applied to the diviſions by means of a tightening ſcrew.

Two upright poſts of wood or ſtone YY, firmly fixed at a proper diſtance, are to ſuſtain the ſupporters of this inſtrument. Theſe ſupporters are two thick braſs plates RR, having well ſmoothed angular notches in their upper ends, to receive the cylindrical arms of the axis. Each of theſe notched plates is contrived to be moveable by a ſcrew which ſlides them upon the ſurfaces of two other plates immoveably fixed upon the two upright pillars; one plate moving in an horizontal, and the other in a vertical, direction; or, which is more ſimple, theſe two modes are ſometimes applied only on one ſide, as at V and P, the horizontal motion by the ſcrew P, and the vertical by the ſcrew V. Theſe two motions ſerve to adjuſt the teleſcope to the planes of the horizon and meridian: to the plane of the horizon by the ſpirit-level EF, hung by DC on the axis MQ, in a parallel direction; and to the plane of the meridian in the following manner:

Obſerve by the clock when a circumpolar ſtar ſeen through this inſtrument tranſits both above and below the pole; and if the times of deſcribing the eaſtern and weſtern parts of its circuit are equal, the teleſcope is then in the plane of the meridian: otherwiſe the ſcrew P muſt be gently turned that it may move the teleſcope

Aſtronomical Inſtruments.

ſcope ſo much that the time of the ſtar's revolution be biſected by both the upper and lower tranſits, taking care at the ſame time that the axis remains perfectly horizontal. When the teleſcope is thus adjuſted, a mark muſt be ſet at a conſiderable diſtance (the greater the better) in the horizontal direction of the interſection of the croſs wires, and in a place where it can be illuminated in the night-time by a lanthorn hanging near it; which mark being on a fixed object, will ſerve at all times afterwards to examine the poſition of the teleſcope by, the axis of the inſtrument being firſt adjuſted by means of the level.

501 *To adjuſt the Clock by the Sun's Tranſit over the Meridian.* Note the times by the clock when the preceding and following edges of the ſun's limb touch the croſs-wires. The difference between the middle time and 12 hours, ſhows how much the mean, or time by the clock, is faſter or ſlower than the apparent, or ſolar time, for that day; to which the equation of time being applied, will ſhow the time of mean noon for that day, by which the clock may be adjuſted.

502 2. *The Equal Altitude Inſtrument* is an inſtrument that is uſed to obſerve a celeſtial object when it has the ſame altitude on both the eaſt and weſt ſides of the meridian, or in the morning and afternoon. It principally conſiſts of a teleſcope about 30 inches long fixed to a ſextantal or ſemicircular divided arch; the centre of which is fixed to a long vertical axis; but the particulars of the inſtrument the reader will ſee explained in Optics, Part III.

503 3. *Compound Tranſit Inſtrument.* Some inſtruments have been contrived to anſwer both kinds of obſervations, viz. either a tranſit or equal altitudes. Fig. 222 repreſents ſuch an inſtrument, made firſt of all for Mr Le Monnier the French aſtronomer, by the late Mr Siſſon, under the direction of Mr Opaham, mounted and fixed up ready for obſervation.

AB is a teleſcope, which may be 3, 4, 5, or 6 feet long, whoſe cylindrical tube fits exactly into another hollow cylinder *a b*, perpendicular to the axis: theſe ſeveral pieces are of the beſt hammered plate braſs. The cylindrical extremity of this axis NN are of ſolid bell-metal, and wrought exquiſitely true, and exactly of the ſame ſize in a lathe; and it is on the perfection to which the cylinders or trunnions are turned that the juſtneſs of the inſtrument depends. In the common focus of the object-glaſs and eye-glaſs is placed a reticle (fig. 223.) conſiſting of three horizontal and parallel fine-ſtretched ſilver wires, fixed by pins or ſcrews to a braſs circle, the middle one paſſing through its centre, with a fourth vertical wire likewiſe paſſing through the centre, exactly perpendicular to the former three.

The horizontal axis MN (fig. 222.) is placed on a ſtrong braſs frame, into the middle of which a ſteel cylinder GH is fixed perpendicularly, being turned truly round, and terminating in a conical point at its lower extremity; where it is let into a ſmall hole drilled in the middle of the dove-tail ſlider; which ſlider is ſupported by a hollow cube fixed to the ſupporting piece IK, conſiſting of two ſtrong plates of braſs, joined together at right angles, to which are fixed two iron cramps LL, by which it is faſtened to the ſtone-wall of a ſouth window.

The upper part G of the ſteel ſpindle is embraced by a collar *d e f*, being in contact with the blunt extremity of three ſcrews, whoſe particular uſe will be explained by and by. O is another cylindrical collar cloſely embracing the ſteel ſpindle at about a third part of its length from the top; by the means of a ſmall ſcrew it may be looſened or pinched cloſe as occaſion requires. From the bottom of this collar proceeds an arm or lever acted upon by the two ſcrews *g h*, whereby the whole inſtrument, excepting the ſupporting piece, may be moved laterally, ſo that the teleſcope may be made to point at a diſtant mark fixed in the vertical of the meridian. *i k* is a graduated ſemicircle of thin braſs ſcrewed to the teleſcope, whereby it may be elevated ſo as to point to a known celeſtial object in the day-time. *l m* is a ſpirit-level parallel to the axis of rotation on the teleſcope, on which two trunnions hang by two hooks at M and N. Along the upper ſide of the glaſs tube of the level ſlides a pointer to be ſet to the end of the air-bubble; and when the poſition of the axis of rotation is ſo adjuſted by the ſcrews that the air-bubble keeps to the pointer for a whole revolution of the inſtrument, the ſpindle GH is certainly perpendicular to the horizon, and then the line of collimation of the teleſcope deſcribes a circle of equal altitude in the heavens. When the level is ſuſpended on the axis, raiſe or depreſs the tube of the level by twiſting the neb of the ſcrew *n* till you bring either end of the air-bubble to reſt at any point towards the middle of the tube, to which ſlide the index; then lift off the level, and, turning the ends of it contrary ways, hang it again on the trunnions; and if the air-bubble reſts exactly again the index as before, the axis of rotation is truly horizontal: If not, depreſs that end of the axis which lies on the ſame ſide of the pointer as the bubble does, by turning the neb of the ſcrew at N, till the bubble returns about halfway towards the pointer; then having moved the pointer to the place where it now reſts, invert the ends of the level again, and repeat the ſame practice till the bubble reſts exactly at the pointer in both poſitions of the level. If, after the teleſcope is turned upſide down, that is, after the trunnions are inverted end for end, you perceive that the ſame point of a remote fixed object is covered by the vertical wire in the focus of the teleſcope that was covered by it before the inverſion, it is certain that the line of ſight or collimation is perpendicular to the tranſverſe axis; but if the ſaid vertical wire covers any other point, the braſs circle that carries the hairs muſt be moved by a ſcrew-key introduced through the perforation in the ſide of the tube at X, till it appears to biſect the line joining theſe two points, as near as you can judge; then, by reverting the axis to its former poſition, you will find whether the wires be exactly adjuſted. *N. B.* The ball *o* is a counterpoiſe to the centre of gravity of the ſemicircle *i k*, without which the teleſcope would not reſt in an oblique elevation without being fixed by a ſcrew or ſome other contrivance.

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The ſeveral beforementioned verifications being accompliſhed, if the teleſcope be elevated to any angle with the horizon and there ſtopped, all fixed ſtars which paſs over the three horizontal wires of the reticle on the eaſtern ſide of the meridian in aſcending, will have preciſely the ſame altitudes when in deſcending they again croſs the ſame reſpective wires on the weſt

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west side, and the middle between the times of each respective equal altitude will be the exact moment of the star's culminating or passing the meridian. By the help of a good pendulum-clock, the hour of their true meridional transits will be known, and consequently the difference of right ascension of different stars. Now, since it will be sufficient to observe a star which has north declination two or three hours before and after its passing the meridian, in order to deduce the time of its arrival at that circle; it follows, that having once found the difference of right ascension of two stars about 60 degrees asunder, and you again observe the first of these stand at the same altitude both in the east and west side, you infer with certainty the moment by the clock at which the second star will be on the meridian that same night, and by this means the transit-instrument may be fixed in the true plane of the meridian till the next day; when, by depressing it to some distant land objects, a mark may be discovered whereby it may ever after be rectified very readily, so as to take the transits of any of the heavenly bodies to great exactness, whether by night or day.

When such a mark is thus found, the telescope being directed carefully to it, must be fixed in that position by pinching fast the end of the arm or lever between the two opposite screws *g h*; and if at any future time, whether from the effect of heat or cold on the wall to which the instrument is fixed, or by any settling of the wall itself, the mark appears no longer well bisected by the vertical wire, the telescope may easily be made to bisect it again, by giving a small motion to the pinching screws. Astronomical Instruments.

The transit-instrument is now considered as one of the most essential particulars of the apparatus of an astronomical observatory.

Besides the above may be mentioned,

The EQUATORIAL *or* PORTABLE OBSERVATORY; 504
an instrument designed to answer a number of useful purposes in practical astronomy, independent of any particular observatory. It may be made use of in any steady room or place, and performs most of the useful problems in the science. The following is a description of one lately invented by Mr Ramsden, from whom it has received the name of the *Universal Equatorial*.

The principal parts of this instrument (fig. 221.) are, 1. The azimuth or horizontal circle A, which represents the horizon of the place, and moves on a long axis B, called the *vertical axis*. 2. The equatorial or hour-circle C, representing the equator, placed at right angles to the polar axis D, or the axis of the earth, upon which it moves. 3. The semicircle of declination E, on which the telescope is placed, and moving on the axis of declination, or the axis of motion of the line of collimation F. These circles are measured and divided as in the following table:

Measures of the several circles and divisions on them.	Radius In. dec.	Limb divided to	Nonius of 30 gives seconds	Divided on limb into parts of inc.	Divided by Nonius into parts of inch.
Azimuth or horizontal circle	5 1	15′	30″	45th	1350th
Equatorial or hour circle	5 1	15′ / 1′ in time	30″ / 2″	45th	1350th
Vertical semicircle for declination or latitude	5 5	15′	30″	42d	1260th

4. The telescope, which is an achromatic refractor with a triple object-glass, whose focal distance is 17 inches, and aperture 2.45 inches, and furnished with six different eye-tubes; so that its magnifying powers extend from 44 to 168. The telescope in this equatorial may be brought parallel to the polar axis, as in the figure, so as to point to the pole-star in any part of its diurnal revolution; and thus it has been observed near noon, when the sun has shone very bright.
5. The apparatus for correcting the error in altitude occasioned by refraction, which is applied to the eye-end of the telescope, and consists of a slide G moving in a groove or dove-tail, and carrying the several eye-tubes of the telescope, on which slide there is an index corresponding to five small divisions engraved on the dove-tail; a very small circle, called the refraction circle H, moveable by a finger-screw at the extremity of the eye-end of the telescope; which circle is divided into half-minutes, one entire revolution of it being equal to 3′ 18″, and by its motion raises the centre of the cross-hairs on a circle of altitude; and likewise a quadrant I of $1\frac{1}{4}$ inch radius, with divisions on each side, one expressing the degree of altitude of the object viewed, and the other expressing the minutes and seconds of error occasioned by refraction, corresponding to that degree of altitude: to this quadrant is joined a small round level K, which is adjusted partly by the pinion that turns the whole of this apparatus, and partly by the index of the quadrant: for which purpose the refraction circle is set to the same minute, &c. which the index points to on the limb of the quadrant; and if the minute, &c. given by the quadrant exceed the 3′ 18″ contained in one entire revolution of the refraction circle, this must be set to the excess above one or more of its entire revolutions; then the centre of the cross-hairs will apppear to be raised on a circle of altitude to the additional height which the error of refraction will occasion at that altitude.

This instrument stands on three feet L distant from each other 14,4 inches; and when all the parts are horizontal is about 29 inches high: the weight of the equatorial and apparatus is only 59 lb. avoirdupoise, which are contained in a mahogany case weighing 58 lb.

The principal adjustment in this instrument is that of making the line of collimation to describe a portion of an hour-circle in the heavens; in order to which, the azimuth circle must be truly level, the line of collimation

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limation or ſome correſponding line repreſented by the ſmall braſs rod M parallel to it, muſt be perpendicular to the axis of its own proper motion; and this laſt axis muſt be perpendicular to the polar axis: on the braſs rod M there is occaſionally placed a hanging level N, the uſe of which will appear in the following adjuſtments:

The azimuth circle may be made level by turning the inſtrument till one of the levels is parallel to an imaginary line joining two of the feet ſcrews; then adjuſt that level with theſe two feet ſcrews; turn the circle half round, *i. e.* 180°; and if the bubble be not then right, correct half the error by the ſcrew belonging to the level, and the other half error by the two foot ſcrews; repeat this till the bubble comes right; then turn the circle 90° from the two former poſitions, and ſet the bubble right, if it be wrong, by the ſoot ſcrew at the end of the level; when this is done, adjuſt the other level by its own ſcrew, and the azimuth circle will be truly level. The hanging level muſt then be fixed to the braſs rod by two hooks of equal length, and made truly parallel to it: for this purpoſe make the polar axis perpendicular or nearly perpendicular to the horizon; then adjuſt the level by the pinion of the declination-ſemicircle; reverſe the level, and if it be wrong, correct half the error by a ſmall ſteel ſcrew that lies under one end of the level, and the other half error by the pinion of the declination-ſemicircle; repeat this till the bubble be right in both poſitions. In order to make the braſs rod on which the level is ſuſpended at right angles to the axis of motion of the teleſcope or line of collimation, make the polar axis horizontal, or nearly ſo: ſet the declination-ſemicircle to 0°, turn the hour-circle till the bubble comes right; then turn the declination-circle to 90°; adjuſt the bubble by raiſing or depreſſing the polar axis (firſt by hand till it be nearly right, afterwards tighten with an ivory key the ſocket which runs on the arch with the polar axis, and then apply the ſame ivory key to the adjuſting ſcrew at the end of the ſaid arch till the bubble comes quite right); then turn the declination-circle to the oppoſite 90; if the level be not then right, correct half the error by the aforeſaid adjuſting ſcrew at the end of the arch, and the other half error by the two ſcrews which raiſe or depreſs the end of the braſs rod. The polar axis remaining nearly horizontal as before, and the declination-ſemicircle at 0°, adjuſt the bubble by the hour-circle; then turn the declination-ſemicircle to 90°, and adjuſt the bubble by raiſing or depreſſing the polar axis; then turn the hour-circle 12 hours; and if the bubble be wrong, correct half the error by the polar axis, and the other half error by the two pair of capſtan ſcrews at the feet of the two ſupports on one ſide of the axis of motion of the teleſcope; and thus this axis will be at right angles to the polar axis. The next adjuſtment is to make the centre of croſs-hairs remain on the ſame object, while you turn the eye-tube quite round by the pinion of the refraction apparatus: for this adjuſtment, ſet the index on the ſlide to the firſt diviſion on the dove-tail; and ſet the diviſion marked 18″ on the refraction-circle to its index; then look through the teleſcope, and with the pinion turn the eye-tube quite round; and if the centre of the hairs does not remain on the ſame ſpot during that revolution, it muſt be corrected by the four ſmall ſcrews, two and two at a time (which you will find upon unſcrewing the neareſt end of the eye-tube that contains the firſt eye-glaſs); repeat this correction till the centre of the hairs remains on the ſpot you are looking at during an entire revolution. In order to make the line of collimation parallel to the braſs rod on which the level hangs, ſet the polar axis horizontal, and the declination-circle to 90°, adjuſt the level by the polar axis; look through the teleſcope on ſome diſtant horizontal object, covered by the centre of the croſs hairs; then invert the teleſcope, which is done by turning the hour-circle half round; and if the centre of the croſs hairs does not cover the ſame object as before, correct half the error by the uppermoſt and lowermoſt of the four ſmall ſcrews at the eye-end of the large tube of the teleſcope; this correction will give a ſecond object now covered by the centre of the hairs, which muſt be adopted inſtead of the firſt object: then invert the teleſcope as before; and if the ſecond object be not covered by the centre of the hairs, correct half the error by the ſame two ſcrews which were uſed before: this correction will give a third object, now covered by the centre of the hairs, which muſt be adopted inſtead of the ſecond object; repeat this operation till no error remains; then ſet the hour-circle exactly to 12 hours (the declination-circle remaining at 90° as before); and if the centre of the croſs hairs does not cover the laſt object fixed on, ſet it to that object by the two remaining ſmall ſcrews at the eye-end of the large tube, and then the line of collimation will be parallel to the braſs rod. For rectifying the nonius of the declination and equatorial circles, lower the teleſcope as many degrees, minutes, and ſeconds, below 0° or Æ on the declination-ſemicircle as are equal to the complement of the latitude; then elevate the polar axis till the bubble be horizontal, and thus the equatorial circle will be elevated to the co-latitude of the place; ſet this circle to 6 hours; adjuſt the level by the pinion of the declination-circle; then turn the equatorial circle exactly 12 hours from the laſt poſition; and if the level be not right, correct one half of the error by the equatorial circle, and the other half by the declination-circle; then turn the equatorial circle back again exactly 12 hours from the laſt poſition; and if the level be ſtill wrong, repeat the correction as before till it be right, when turned to either poſition; that being done, ſet the nonius of the equatorial circle exactly to 6 hours, and the nonius of the declination-circle exactly to 0°.

Aſtronomical Inſtruments.

The principal uſes of this equatorial are,

1. To find your meridian by one obſervation only: for this purpoſe, elevate the equatorial circle to the co-latitude of the place, and ſet the declination-ſemicircle to the ſun's declination for the day and hour of the day required; then move the azimuth and hour-circles both at the ſame time, either in the ſame or contrary direction, till you bring the centre of the croſs hairs in the teleſcope exactly to cover the centre of the ſun; when that is done, the index of the hour-circle will give the apparent or ſolar time at the inſtant of obſervation; and thus the time is gained, though the ſun be at a diſtance from the meridian; then turn the hour-circle till the index points preciſely at 12 o'clock, and lower the teleſcope to the horizon, in order to obſerve ſome point there-

ASTRONOMY.

Plate XC.

Fig. 219.

Portable ASTRONOMICAL Quadrant.

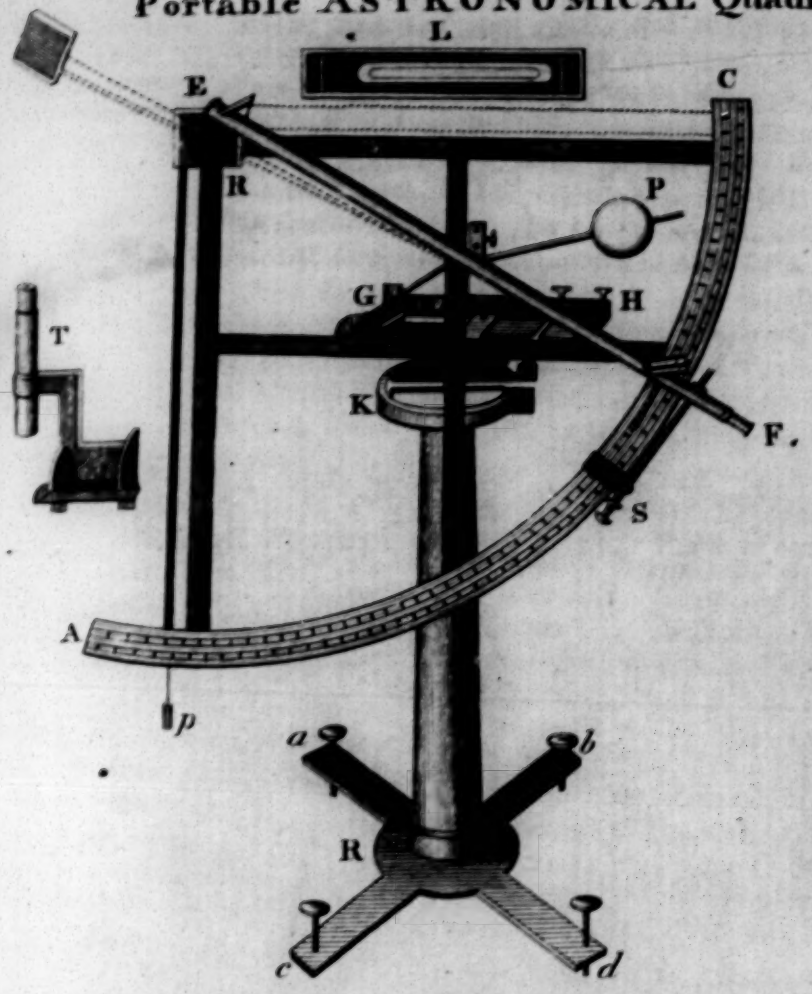


Fig. 220.

Tranſit Inſtrument

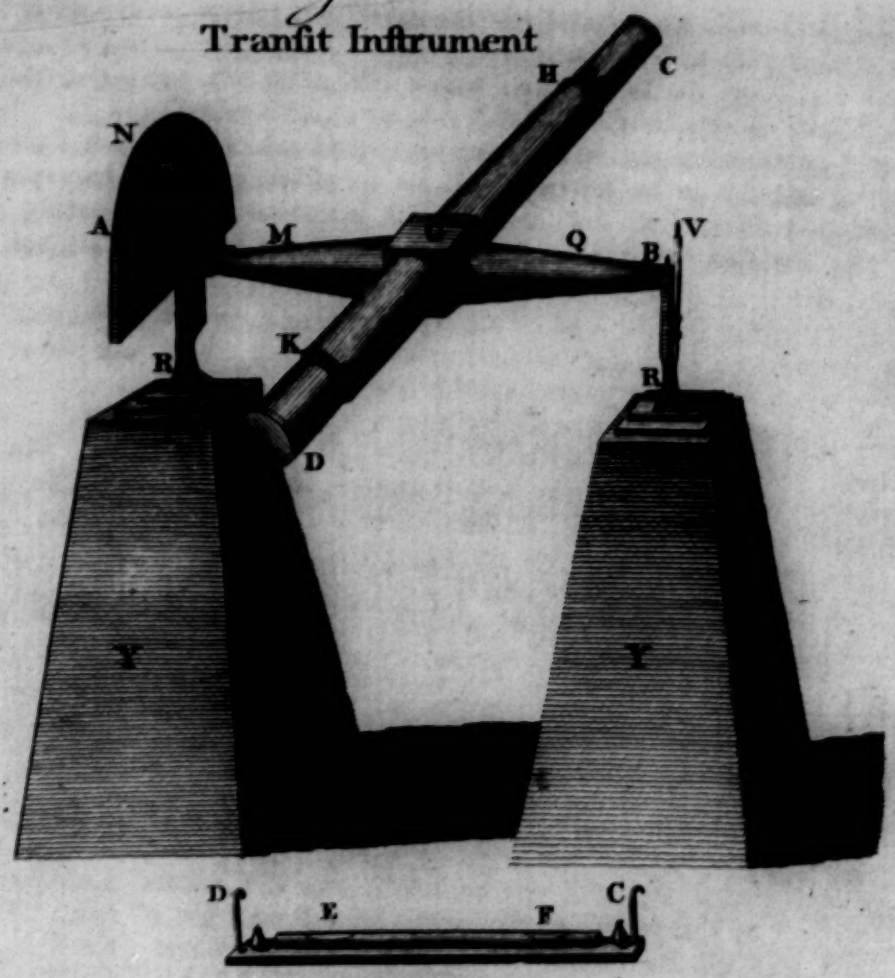


Fig. 221.

Univerſal Equatorial.

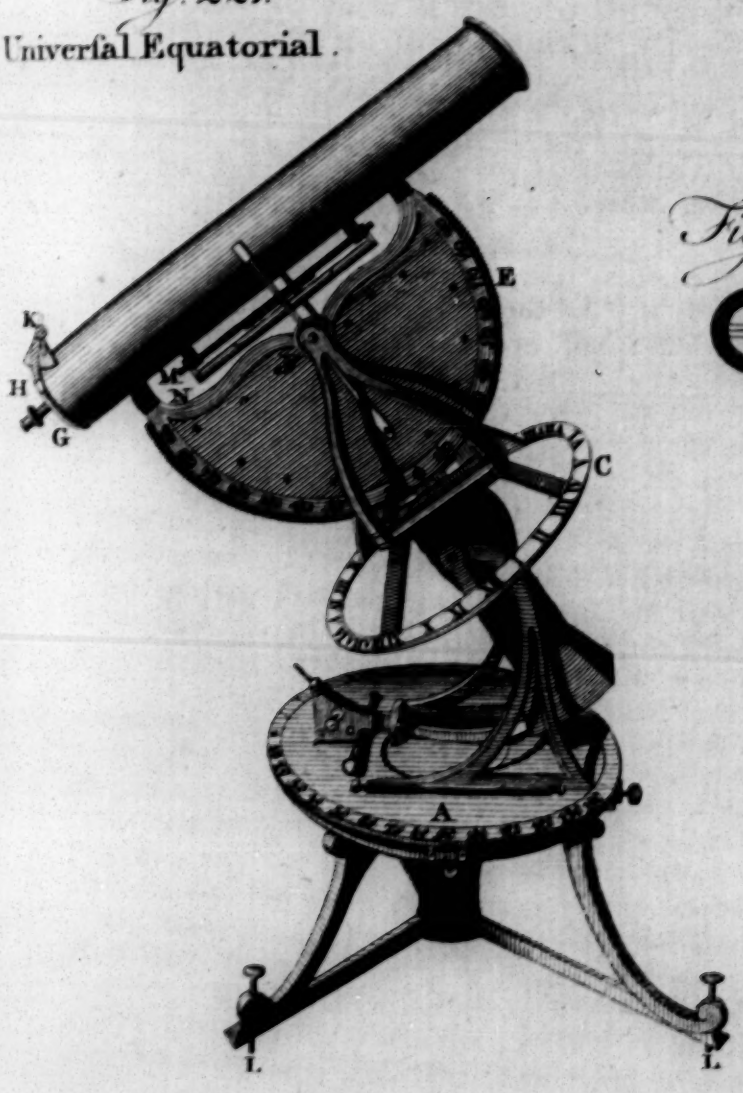
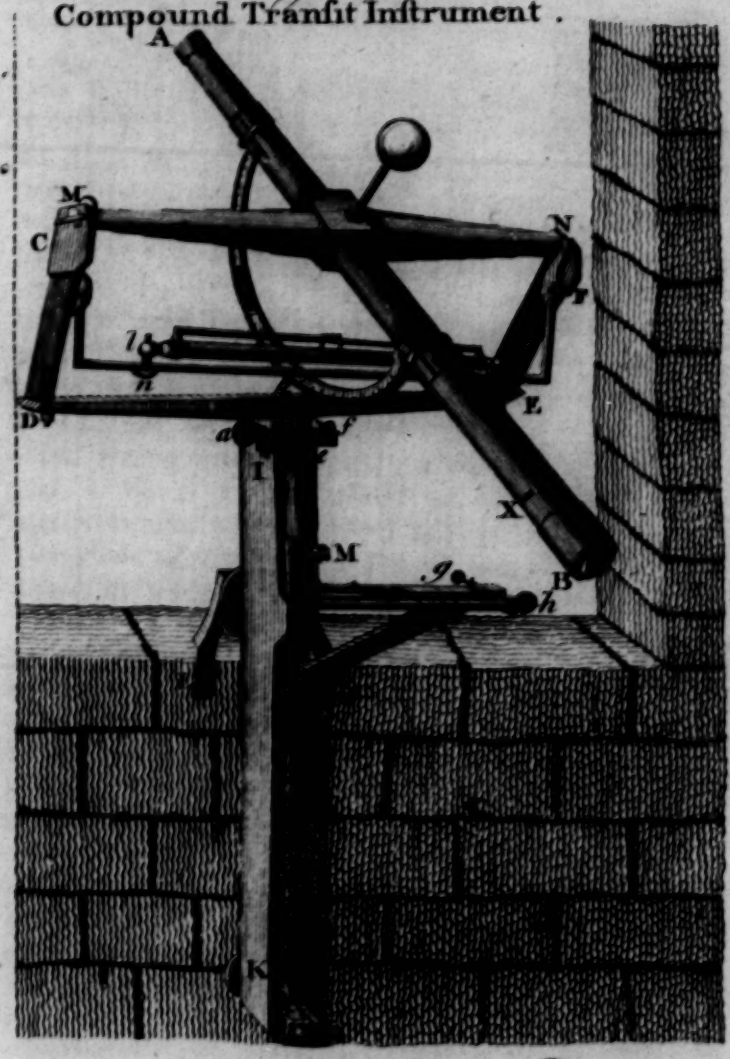


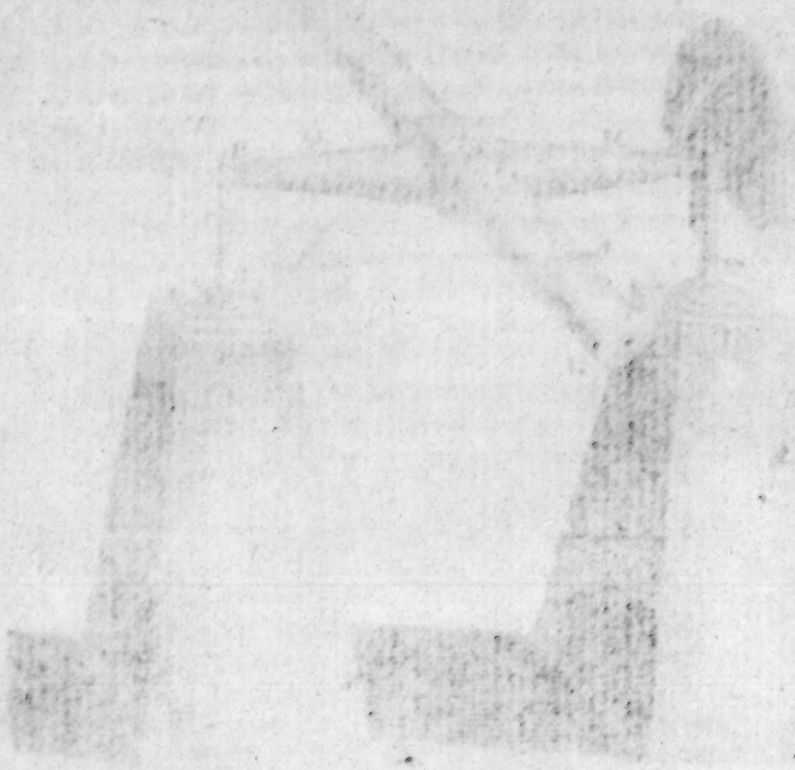
Fig. 223.

Fig. 222.

Compound Tranſit Inſtrument.



Thackara & Vallance ſculp.



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in the centre of your glaſs, and that point is your meridian mark found by one obſervation only; the beſt time for this operation is three hours before or three hours after 12 at noon.

2. To point the teleſcope on a ſtar, though not on the meridian, in full day-light. Having elevated the equatorial circle to the co-latitude of the place, and ſet the declination-ſemicircle to the ſtar's declination, move the index of the hour-circle till it ſhall point to the preciſe time at which the ſtar is then diſtant from the meridian, found in tables of the right aſcenſion of the ſtars, and the ſtar will then appear in the glaſs. Beſides theſe uſes peculiar to this inſtrument, it is alſo applicable to all the purpoſes to which the principal aſtronomical inſtruments, viz. a tranſit, a quadrant, and an equal-altitude inſtrument, are applied.

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Aſtrope-Wells | Aſtruc.

ASTROPE-WELLS, near Banbury in Oxfordſhire, are recommended as excellent in female obſtructions, the gravel, hypochondriac, and ſimilar diſorders. The water is a briſk, ſpirituous, pleaſant-taſted chalybeate, and is alſo gently purgative. It ſhould be drank from three to five quarts in the forenoon.

ASTROSCOPE, a kind of aſtronomical inſtrument, compoſed of two cones, on whoſe ſurface the conſtellations, with their ſtars, are delineated, by means whereof the ſtars may eaſily be known. The aſtroſcope is the invention of William Schukhard, formerly profeſſor of mathematics at Tubingen, who publiſhed a treatiſe expreſsly on it in 1698.

ASTRUC (John), a celebrated phyſician, was born in the year 1684, at the little town of Savoy, in the province of Languedoc. His father, who was a proteſtant clergyman, beſtowed particular pains upon the earlieſt part of his education. After which he went to the univerſity of Montpelier, where he was created maſter of arts in the year 1700. He then began the ſtudy of medicine; and, in two years, obtained the degree of bachelor, having, upon that occaſion, written a diſſertation on the cauſe of fermentation, which he defended in a very ſpirited manner. On the 25th of January 1703 he was created doctor of phyſic; after which, before arriving at extenſive practice, he applied to the ſtudy of medical authors, both ancient and modern, with uncommon aſſiduity. The good effects of his ſtudy ſoon appeared; for, in the year 1710, he publiſhed a treatiſe concerning muſcular motion, from which he acquired very high reputation. In the year 1717, he was appointed to teach medicine at Montpelier; which he did with ſuch perſpicuity and eloquence, that it was univerſally ſaid he had been born to be a profeſſor. His fame ſoon roſe to ſuch a height, that the king aſſigned him an annual ſalary; and he was, at the ſame time, appointed to ſuperintend the mineral waters in the province of Languedoc. But as Montpelier did not afford ſufficient ſcope for his aſpiring genius, he went to Paris with a great ſtock of manuſcripts, which he intended to publiſh, after ſubjecting them to the examination of the learned. Soon after, however, he left it, having in the year 1729 accepted the office of firſt phyſician to the king of Poland, which was then offered to him. His ſtay in Poland, however, was but of ſhort duration, and he again returned to Paris. Upon the death of the celebrated Geoffroy, in the year 1731, he was appointed Regius Profeſſor of medicine at Paris. The duties of this office he diſcharged in ſuch a manner as to anſwer even the moſt ſanguine expectations. He taught the practice of phyſic with ſo great applauſe, as to draw from other univerſities to that of Paris a great concourſe of medical ſtudents, foreigners as well as natives of France. At the ſame time he was not more celebrated as a profeſſor than a practitioner. And, even at an advanced age, he perſiſted with unwearied aſſiduity in that intenſe ſtudy which firſt raiſed his reputation. Hence it is, that he has been enabled to tranſmit to poſterity ſo many valuable monuments of his medical erudition. He died, univerſally regretted, on the 15th of May 1766, in the 82d year of his age.

Aſturia.

ASTURIA, an ancient kingdom of Spain, ſubdued by Auguſtus emperor of Rome.—The inhabitants of this country, along with thoſe of Cantabria, aſſerted their liberty long after the reſt of Spain had received the Roman yoke. So great was their deſire of liberty, that, after being cloſely ſhut up by the Roman army, they endured the moſt terrible calamities of famine, even to the devouring of one another, rather than ſubmit to the enemy. At length, however, the Aſturians were for ſurrendering: but the Cantabrians oppoſed this meaſure, maintaining that they ought all to die ſword in hand like brave men. Upon this the two nations quarrelled, notwithſtanding their deſperate ſituation; and a battle enſuing, 10,000 of the Aſturians were driven to the intrenchments of the Romans, whom

Aſturias | Aſylum.

whom they begged in the moſt moving manner to receive them on any terms they pleaſed. But Tiberius the emperor's ſon-in-law refuſing to admit them into the camp, ſome of theſe unhappy people put an end to their lives by falling upon their own ſwords; others lighting great fires threw themſelves into them, while ſome poiſoned themſelves by drinking the juice of a venomous herb.

The campaign being put an end to by winter, the next year the Aſturians ſummoned all their ſtrength and reſolution againſt the Romans; but notwithſtanding their utmoſt efforts of valour and deſpair, they were entirely defeated in a moſt bloody battle which laſted two days, and for that time entirely ſubdued. A few years afterwards they rebelled, in conjunction with the Cantabrians; but were ſoon reduced by the Romans, who maſſacred moſt of the young men that were capable of bearing arms. This did not prevent them from revolting anew in a ſhort time afterwards; but without ſucceſs, being obliged to ſubmit to the Roman power, till the ſubverſion of that empire by the Goths.

ASTURIAS, anciently the kingdom of Aſturia, is now a principality of modern Spain, bounded by Biſcay on the eaſt, Galicia on the weſt, Caſtile and Old Leon on the ſouth, and the ſea on the north. Its greateſt length is about 110 miles, and its breadth 54. On the ſouth it is ſeparated from Caſtile and Old Leon by high mountains covered with woods. The province is tolerably fertile, but thinly inhabited. The inhabitants value themſelves much on being deſcended from the ancient Goths. Even the poor peaſants, who are fain to go to ſeek work in other provinces, call themſelves *illuſtrious Goths* and *Mountaineers*, thinking it ignominious to marry even with great and rich families of another race. This pride is flattered by the reſpect paid them by the reſt of the nation, and the privileges beſtowed upon them by the government. The hereditary prince of Spain is ſtyled *prince of the Aſturias*. The moſt remarkable places in this principality are Oviedo, Gyon, Santillana, and St Andero.

ASTYAGES, ſon of Cyaxares, the laſt king of the Medes. He dreamed that from the womb of his daughter Mandane, married to Cambyſes king of Perſia, there ſprung a vine that ſpread itſelf over all Aſia. She being with child, he reſolved to kill the infant as ſoon as born. Its name was Cyrus; and Harpagus, being ſent to deſtroy it, preſerved it: which Aſtyages after a long time hearing of, he cauſed Harpagus to eat his own ſon. Harpagus called in Cyrus, who dethroned his grandfather, and thereby ended the monarchy of the Medes. See MEDIA and PERSIA.

ASTYANAX, the only ſon of Hector and Andromache. After the taking of Troy, he was thrown from the top of a tower by Ulyſſes's orders.

ASTYNOMI, in Grecian antiquity, magiſtrates in Athens, correſponding to the ædiles of the Romans; they were ten in number. See ÆDILE.

ASYLUM, a ſanctuary, or place of refuge, where criminals ſhelter themſelves from the hands of juſtice. The word is compounded of the primitive particle α, and συλαω, *I hurt*; becauſe no perſon could be taken out of an aſylum without ſacrilege.

The aſyla of altars and temples were very ancient; and likewiſe thoſe of tombs, ſtatues, and other monuments of conſiderable perſonages. Thus, the temple of Diana at Epheſus was a refuge for debtors, the tomb of Theſeus for ſlaves. Among the Romans, a celebrated aſylum was opened by Romulus between the mounts Palatine and Capitoline, in order to people Rome, for all ſorts of perſons indiſcriminately, fugitive ſlaves, debtors, and criminals of every kind. The Jews had their aſyla; the moſt remarkable of which were, the ſix cities of refuge, the temple, and the altar of burnt-offerings. Aſylum | Aſyndeton.

It was cuſtomary among the Heathens to allow refuge and impunity even to the vileſt and moſt flagrant offenders: ſome out of ſuperſtition, and others for the ſake of peopling their cities: and it was by this means, and with ſuch inhabitants, that Thebes, Athens, and Rome, were firſt ſtocked. We even read of aſylums at Lyons and Vienne among the ancient Gauls; and there are ſome cities in Germany which ſtill preſerve the ancient right of aſylum. Hence on the medals of ſeveral ancient cities, particularly in Syria, we meet with the inſcription ΑΣΥΛΟΙ, to which is added ΙΕΡΑΙ. This quality of aſylum was given them, according to M. Spanheim, in regard to their temples, and to the gods revered by them.

The emperors Honorius and Theodoſius granting the like immunities to churches, the biſhops and monks laid hold of a certain tract or territory, without which they fixed the bounds of the ſecular juriſdiction: and ſo well did they manage their privileges, that convents in a little time became next akin to fortreſſes; where the moſt notorious villians were in ſafety, and braved the power of the magiſtrate.

Theſe privileges at length were extended not only to the churches and church-yards, but alſo to the biſhops houſes; whence the criminal could not be removed without a legal aſſurance of life, and an entire remiſſion of the crime. The reaſon of the extenſion was, that they might not be obliged to live altogether in the churches, &c. where ſeveral of the occaſions of life could not be decently performed.

But at length theſe aſyla or ſanctuaries were alſo ſtripped of moſt of their immunities, becauſe they ſerved to make guilt and libertinage more bold and daring. In England, particularly, they were entirely aboliſhed. See SANCTUARY.

ASYMMETRY, the want of proportion between the parts of any thing; being the contrary of *ſymmetry*.

ASYMPTOTE, in geometry, a line which continually approaches nearer to another; but, though continued infinitely, will never meet with it: Of theſe are many kinds. In ſtrictneſs, however, the term *aſymptotes* is appropriated to right lines, which approach nearer and nearer to ſome curves of which they are ſaid to be *aſymptotes*; but if they and their curves are indefinitely continued, they will never meet. See *Conic Sections*.

ASYNDETON, in grammar, a figure which omits the conjunctions in a ſentence. As in *veni, vidi, vici*, where ET is left out: or in that of Cicero concerning Catiline, *abiit, exceſſit, evaſit, erupit:* or in that verſe of Virgil,

Ferte citi flammas, date vela, impellite remos.

Aſyndeton ſtands oppoſed to polyſyndeton, where the copulatives are multiplied.

Atabulus | Ate.

ATABULUS, in phyſiology, a provincial wind in Apulia, of a dry pinching quality, and very noxious in its effects. The ancient naturaliſts ſpeak of the Atabulus in terms of horror, on account of the ravage it made among the fruits of the earth, which it ſcorched or withered up.

ATABYRIS, a very high mountain in the iſland of Rhodes, on which, according to Strabo and Diodorus Siculus, there ſtood a temple of Jupiter Atabyrius, whoſe worſhip a colony of Rhodians carried into Sicily, where a temple was built to the ſame deity at Agrigentum.

ATALANTA, an iſland in the Euripus of Eubœa, near the Locri Opuntii, ſaid to have been originally a city of the Locri, but torn from the continent in the time of an earthquake, and during an irruption of mount Ætna. This happened in the fourth year of the 93d Olympiad, in the reign of Artaxerxes Mnemon (Pliny, Oroſius).

ATALANTIS, ATLANTICA, or ATLANTIS. See ATLANTIS.

ATARAXY, a term uſed by the ſtoics and ſceptics, to denote that calmneſs of mind which ſecures us from all emotions ariſing from vanity and ſelf-conceit.

ATARGATIS FANUM, the temple of a goddeſs worſhipped by the Syrians and Parthians, having the face of a woman and tail of a fiſh, and called *Derceto* by the Greeks. Her temple ſtood in the city Bambyce, called afterwards *Hierapolis*. It was extremely rich, inſomuch that Craſſus, in his march againſt the Parthians, ſpent ſeveral days in weighing the treaſure. Voſſius makes the name of this goddeſs Phœnician, from *Addir-dag*, "the great fiſh."

ATARNEA, an ancient town of Myſia, ſituated between Adramyttium and Pitane, remarkable for the marriage of Ariſtotle with the ſiſter or concubine of the tyrant Hermias; alſo for the dottage of that philoſopher.

ATAXY, in a general ſenſe, the want of order: With phyſicians, it ſignifies irregularity of criſes and paroxyſms of fevers.

ATCHE, in commerce, a ſmall ſilver coin uſed in Turkey, and worth only one-third of the Engliſh penny.

ATCHIEVEMENT, in heraldry, denotes the arms of a perſon or family, together with all the exterior ornaments of the ſhield; as helmet, mantle, creſt, ſcrolls, and motto, together with ſuch quarterings as may have been acquired by alliances, all marſhalled in order.

ATCHIEVE. This term is derived from the French *achever*, i. e. to finiſh or make an end of; but ſignifies, in its ordinary acceptation, to perform great actions or exploits.

ATE, the goddeſs of miſchief, in the Pagan theology. She was daughter of Jupiter, and caſt down from heaven at the birth of Hercules. For Juno having deceived Jupiter, in cauſing Euriſtheus to be born before Hercules, Jupiter expreſſed his reſentment on Ate, as the author of that miſchief: and threw her headlong from heaven to earth, ſwearing ſhe ſhould never return thither again (*Homeri Il.* xix. 125.) The name of this goddeſs comes from ατaω, *noceo*, to "hurt." Her being the daughter of Jupiter, means, according to mythologiſts, that no evil happens to us but by the permiſſion of Providence; and her baniſhment to earth denotes the terrible effects of divine juſtice among men.

Ategua | Athamanta.

ATEGUA, or ATTEGUA, an ancient town of Spain, placed by ſome in the road from Antiquara, now Antequera, to Hiſpalis, or Seville; by others near Alcala Real; which laſt is the more probable ſituation, becauſe the flumen ſalſum, now the Salado, was in its neighbourhood. Now *Tebala Vieja*, or *Teivela*.

ATELLA, an ancient town of Campania in Italy, between Capua and Neapolis. From this town the *Atellanæ fabulæ*, or *Atellani ludi*, took their name. Theſe were alſo called *Oſci*, from their inventor, in whoſe territory Atella lay. They were generally a ſpecies of farce, interlarded with much ribaldry and buffoonery; and ſometimes were exordia or interludes preſented between the acts of other plays. The actors in theſe farces were not reckoned among the common players, nor deemed infamous; but retained the rights of their tribe, and might be liſted for ſoldiers, the privilege only of free men. The ruins of this town are ſtill to be ſeen about 11 miles from the modern Averſa, which was built out of its materials.

ATEMPO GIUSTO, in muſic, ſignifies to ſing or play in an equal, true, and juſt time.

ATERGATIS, in mythology, a goddeſs of the Syrians, ſuppoſed to be the mother of Semiramis. She was repreſented with the face and breaſts of a woman, but the reſt of her body reſembled a fiſh. Voſſius ſays the term ſignifies *without fiſh*, and conjectures that the votaries of this deity abſtained from fiſh.

ATERNUM, a town of Lucania in Italy, now *Aterni*, (Cluverus): Alſo a town in the territory of the Piceni, now *Peſcara*, a port-town of Naples, ſituated on the Adriatic, E. Long. 15. 25. N. Lat. 42. 30.

ATESTE, a town in the territory of Venice in Italy, now called *Eſte*. E. Long. 12. 6. N. Lat. 45. 25.

ATHAMADULET, the prime miniſter of the Perſian empire, as the grand vizier is of the Turkiſh empire. He is great chancellor of the kingdom, preſident of the council, ſuperintendant of the finances, and is charged with all foreign affairs.

ATHAMANTA, SPIGNEL: A genus of the dinynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 45th order, *Umbellatæ*. The fruit is oblong and ſtriated; and the petals are inflected and emarginated. Of this genus Linnæus enumerates nine ſpecies; but none of them merit particular notice, except the cretenſis, otherwiſe called *daucus creticus*, which grows wild in the Levant and the warmer parts of Europe. The leaves are irregularly diſpoſed, and formed like thoſe of fennel. The flower-ſtalk riſes about two feet high, ſending out many branches, terminated at the top by compound umbels, compoſed of near 20 ſmall ones. Theſe have white flowers with five petals, which are ſucceeded by oblong, hairy, channelled fruit, divided into two parts, containing one oblong hairy ſeed. The ſeeds have a warm biting taſte, with an agreeable aromatic ſmell. They are kept in the ſhops as a medicine, are carminative, and ſaid to be diuretic; but are little uſed in practice. The plant may be propagated

Athanaſia Athanaſian.

gated from ſeeds, which ſhould be ſown on an open bed of light dry ground; the following autumn the plants ſhould be taken up, and planted at about a foot diſtance in a bed of light ſandy earth, where the roots will continue ſeveral years.

ATHANASIA, GOLDILOCKS: A genus of the polygamia æqualis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ diſcoides*. The receptacle is chaffy; the pappus is chaffy, and very ſhort; and the calyx is imbricated. There are 20 ſpecies, all tender plants except one; and none of them poſſeſſed of beauty, or any remarkable property.

ATHANASIAN CREED; a formulary, or confeſſion of faith, long ſuppoſed to have been drawn up by Athanaſius biſhop of Alexandria, in the fourth century, to juſtify himſelf againſt the calumnies of his Arian enemies. But it is now generally allowed among the learned not to have been his. Dr Waterland aſcribes it to Hilary biſhop of Arles, for the following among other reaſons: 1. Becauſe Honoratus of Marſeilles, the writer of his life, tells us, that he compoſed an *Expoſition of the Creed*: a properer title for the *Athanaſian*, than that of *Creed* ſimply which it now bears. 2. Hilary was a great admirer and follower of St Auſtin; and the whole compoſition of this creed is in a manner upon St Auſtin's plan, both with reſpect to the Trinity and incarnation. 3. It is agreeable to the ſtyle of Hilary, as far as we can judge from the little that is left of his works. Upon the whole, he concludes, that Hilary biſhop of Arles, about the year 430, compoſed *The Expoſition of Faith*, which now bears the name of the *Athanaſian Creed*, for the uſe of the Gallican clergy, and particularly thoſe of the dioceſe of Arles: That, about the year 570, it became famous enough to be commented upon; but that all this while, and for ſeveral years lower, it had not yet acquired the name of *Athanaſian*, but was ſimply ſtyled *The Catholic Faith*: That, before 670, Athanaſius's admired name came in to recommend and adorn it, being in itſelf an excellent ſyſtem of the Athanaſian principles of the Trinity and incarcation, in oppoſition chiefly to the Arians, Macedonians, and Apollinarians. This is the hypotheſis of the learned author of the *Critical Hiſtory of the Athanaſian Creed*.

As to the reception of this creed in the Chriſtian churches, we find, that it obtained in France in the time of Hincmar, or about 850; that it was received in Spain about 100 years later than in France, and in Germany much about the ſame time. As to our own country, we have clear and poſitive proofs of this creed being ſung alternately in our churches in the tenth century. It was in common uſe in ſome parts of Italy, particularly in the dioceſe of Verona, about the year 960, and was received at Rome about the year 1014. As to the Greek and oriental churches, it has been queſtioned whether any of them ever received this creed at all; though ſome very conſiderable writers are of a contrary perſuaſion. It appears then, that the reception of this creed has been both general and ancient; and may vie with any, in that reſpect, except the Nicene, or Conſtantinopolitan, the only general creed common to all the churches.

As to the matter of this creed, it is given as a ſummary of the true orthodox faith, and a condemnation of all hereſies ancient and modern. Unhappily, however, it has proved a fruitful ſource of unprofitable controverſy and unchriſtian animoſity even down to the preſent time.

Athanaſius Athanor.

ATHANASIUS (St), biſhop of Alexandria, and one of the greateſt defenders of the faith againſt the Arians, was born in Egypt. He followed St Alexander to the council of Nice, in 325, where he diſputed againſt Arius, and the following year was made biſhop of Alexandria; but, in 335, was depoſed by the council of Tyre: when, having recourſe to the emperor Conſtantine, the Arian deputies accuſed him of having hindered the exportation of corn from Alexandria to Conſtantinople; on which the emperor, without ſuffering him to make his defence, baniſhed him to Treves. The emperor, two years after, gave orders that he ſhould be reſtored to his biſhopric: but, on his return to Alexandria, his enemies brought freſh accuſations againſt him, and choſe Gregory of Cappadocia to his ſee; which obliged Athanaſius to go to Rome to reclaim it of Pope Julius. He was there declared innocent, in a council held in 342, and in that of Sardica in 347, and two years after was reſtored to his ſee by order of the emperor Conſtans; but after the death of that prince, he was again baniſhed by the emperor Conſtantius, which obliged him to retire into the deſerts. The Arians then elected one George in his room; who being killed in a popular ſedition under Julian in 360, St Athanaſius returned to Alexandria, but was again baniſhed under Julian, and reſtored to his ſee under Jovian. He addreſſed to that emperor a letter, in which he propoſed that the Nicene creed ſhould be the ſtandard of the orthodox faith, and condemned thoſe who denied the divinity of the Holy Ghoſt. He was alſo baniſhed by Valens in 367, and afterwards recalled. St Athanaſius died on the 2d of May 373.

His works principally contain a defence of the myſtery of the Trinity, and of the incarnation and divinity of the Word and Holy Spirit. There are three editions of his works which are eſteemed; that of Commelin, printed in 1600; that of Peter Nannius, in 1627; and that of father Montfaucon. As to the creed which bears his name, ſee the preceding article.

ATHANATI, in Perſian antiquity, a body of cavalry, conſiſting of 10,000 men, always complete. They were called *athanati* (a word originally Greek, and ſignifying *immortal*), becauſe, when one of them happened to die, another was immediately appointed to ſucceed him.

ATHANOR. Chemiſts have diſtinguiſhed by this name a furnace ſo conſtructed that it can always maintain an equal heat, and which ſhall laſt a long time without addition of freſh fuel.

The body of the athanor has nothing in it particular, and is conſtructed like ordinary furnaces. But at one of its ſides, or its middle, there is an upright hollow tower, which communicates with the fire-place by one or more ſloping openings. This tower ought to have a lid which exactly cloſes its upper opening.

When the athanor is to be uſed, as much lighted coal is put in the fire-place as is judged neceſſary, and the tower is filled to the top with unlighted fuel. The

Athanor | Atheiſt.

tower is then to be exactly cloſed with its lid. As faſt as the coal in the fire-place is conſumed, that in the tower falls down and ſupplies its place. As the coal contained in the tower has no free communication with the external air, it cannot burn till it falls into the fire-place.

The athanor being much celebrated and uſed by ancient chemiſts, it has been particularly deſcribed by many authors, and was formerly found in all laboratories. At preſent this furnace is much leſs employed, and is even neglected. The reaſon of this is, that all the ancient chemiſts were in ſearch of the art of making gold; and being excited by this powerful deſire, and confidence of ſucceſs, they ſpared no trouble nor expence to accompliſh this deſign. They undertook, without heſitation, operations which required great length of time and unremitted heat. Whereas now, theſe alluring hopes having vaniſhed, the cultivators of chemiſtry have no other view than to extend and perfect the theory of this eſſential part of natural philoſophy. This motive, although undoubtedly much nobler than the former, ſeems, however, to be leſs powerful over moſt men. For now, all long and laborious operations whence chemiſtry might receive great advantages, are neglected, as being tireſome and diſguſtful. There is, in fact, a conſiderable difference betwixt the hope of explaining a philoſophical phenomenon, and that of obtaining an ingot of gold capable of producing many others. Hence the inſtruments employed in long operations, and particularly the athanor, are now much neglected; and alſo becauſe the fuel in the tower is apt to ſtick there or fall down at once in too great quantity. The lamp-furnace, which is a true athanor, may be ſucceſsfully employed in operations which do not require much heat.

ATHAROTH, or ATROTH, (anc. geog.) the name of ſeveral towns. Two appear to have been in Samaria, in the tribe of Ephraim; the one four miles to the north of Sebaſte, or the city of Samaria; the other in the confines of Benjamin and Ephraim, yet ſo as to be of the reſort of Ephraim rather than of Benjamin (Joſhua). This is the *Atroth-Addar* mentioned Joſhua xvi. 5. from which to Upper Beth-horon extends the greateſt breadth of the tribe of Ephraim.

ATHEISM, the diſbelief of a Deity. See ATHEIST.

ATHEIST, a perſon who does not believe the exiſtence of a Deity. Many people, both ancient and modern, have pretended to atheiſm, or have been reckoned atheiſts by the world; but it is juſtly queſtioned whether any man ſeriouſly adopted ſuch a principle. Theſe pretenſions, therefore, muſt be founded on pride or affectation.

Atheiſm, as abſurd and unreaſonable as it is, has had its martyrs. Lucilio Vanini, an Italian, native of Naples, publicly taught atheiſm in France, about the beginning of the 16th century; and, being convicted of it at Toloufe, was condemned to death. Being preſſed to make public acknowledgement of his crime, and to aſk pardon of God, the king, and juſtice, he anſwered, he did not believe there was a God; that he never offended the king; and, as for juſtice, he wiſhed it to the devil. He confeſſed that he was one of twelve, who parted in company from Naples to ſpread their doctrine in all parts of Europe. His tongue was firſt cut out, and then his body burnt, April 9. 1619.

Atheling | Athenæus

Cicero repreſents it as a probable opinion, that they who apply themſelves to the ſtudy of philoſophy believe there are no gods. This muſt, doubtleſs, be meant of the academic philoſophy, to which Cicero himſelf was attached, and which doubted of every thing. On the contrary, the Newtonian philoſophers are continually recurring to a Deity, whom they always find at the end of their chain of natural cauſes. Some foreigners have even charged them with making too much uſe of the notion of a God in philoſophy, contrary to the rule of Horace:

Nec Deus interſit, niſi dignus vindici nodus.

Among us, the philoſophers have been the principal advocates for the exiſtence of a Deity. Witneſs the writings of Sir Iſaac Newton, Boyle, Ray, Cheyne, Nieuwentyt, &c. To which may be added many others, who, though of the clergy (as was alſo Ray), yet have diſtinguiſhed themſelves by their philoſophical pieces in behalf of the exiſtence of a God; *e. gr.* Derham, Bentley, Whiſton, Samuel and John Clarke, Fenelon, &c. So true is that ſaying of Lord Bacon, that though a ſmattering of philoſophy may lead a man into atheiſm, a deep draught will certainly bring him back again to the belief of a God and Providence.

ATHELING, ADELING, EDLING, ETHLING, or ETHELING, among the Anglo-Saxons, was a title of honour, properly belonging to the heir-apparent, or preſumptive, to the crown. This honourable appellation was firſt conferred by king Edward the Confeſſor on Edgar, to whom he was great uncle, when, being without any iſſue of his own, he intended to make him his heir.

ATHELSTAN, a Saxon king of England, natural ſon of Edward the elder, and grandſon of the great Alfred. He ſucceeded to the crown in 925, and reigned 16 years. There was a remarkable law paſſed by this prince, which ſhows his juſt ſentiments of the advantages of commerce, as well as the early attention to it in this country: it declared, that any merchant who made three voyages on his own account beyond the Britiſh channel or narrow ſeas, ſhould be intitled to the privilege of a thane, or gentleman.

ATHENÆA, in antiquity, a feaſt celebrated by the ancient Greeks in honour of Minerva, who was called *Athene*.

ATHENÆUM, in antiquity, a public place wherein the profeſſors of the liberal arts held their aſſemblies, the rhetoricians declaimed, and the poets rehearſed their performances. Theſe places, of which there were a great number at Athens, were built in the manner of amphitheatres, encompaſſed with ſeats, called *cunei*. The three moſt celebrated Athenæa were thoſe at Athens, at Rome, and at Lyons, the ſecond of which was built by the emperor Adrian.

ATHENÆUS, a phyſician, born in Cilicia, cotemporary with Pliny, and founder of the pneumatic ſect. He taught that the fire, air, water, and earth, are not the true elements, but that their qualities are, viz. heat, cold, moiſture, and dryneſs; and to theſe he added a fifth element, which he called *ſpirit*, whence his ſect had its name.

ATHENÆUS, a Greek grammarian, born at Naucratis

Athenagoras I Athens.

cratis in Egypt in the 3d century, one of the moſt learned men of his time. Of all his works we have none extant but his Deipnoſophis, *i. e.* the ſophiſts at table; there is an infinity of facts and quotations in this work which render it very agreeable to admirers of antiquity.

There was alſo a mathematician of this name, who wrote a treatiſe on mechanics, which is inſerted in the works of the ancient mathematicians, printed at Paris in 1693, in folio, in Greek and Latin.

ATHENAGORAS, an Athenian philoſopher, flouriſhed about the middle of the 2d century; and was remarkable for his zeal for Chriſtianity, and his great learning, as appears from the apology which he addreſſed to the emperors Marcus Aurelius Antoninus and Lucius Commodus.

ATHENODORUS, a famous ſtoic philoſopher, born at Tarſus, went to the court of Auguſtus, and was made by him tutor to Tiberius. Auguſtus had a great eſteem for him, and found him by experience a man of virtue and probity. He uſed to ſpeak very freely to the emperor. He, before he left the court to return home, warned the emperor not to give himſelf up to anger, but, whenever he ſhould be in a paſſion, to rehearſe the 24 letters of the alphabet before he reſolved to ſay or do any thing. He did not live to ſee his bad ſucceſs in the education of Tiberius.

ATHENOPOLIS, a town of the Maſſilienſes, an ancient nation of Gaul. It is conjectured by Harduin to be the ſame with *Telo Martius*, now *Toulon*; by others to be the ſame with *Antipolis* or *Antibes*.

ATHENREE, a town of Ireland in the county of Galway, and province of Connaught. W. Long. 8.5. N. Lat. 53. 14. It is governed by a portrieve, and hath a barrack for three companies of foot. It hath been a place of conſiderable ſtrength; but, like the numerous churches and caſtles which ſurround it, has felt the reſiſtleſs force of time. Some of the walls and towers, however, are ſtill remaining, as monuments of its former grandeur.

ATHENS, a celebrated city of Greece, and capital of the ancient kingdom of Attica, ſituated in E. Long. 53. N. Lat. 38. 5. See ATTICA.

1 By whom founded.

In early times, that which was afterwards called the *citadel* was the whole city; and went under the name of *Cecropia*, from its founder Cecrops, whom the Athenians in after times affirmed to have been the firſt builder of cities, and called this therefore by way of eminence *Polis*, i. e. the city. In the reign of Erichthonius it loſt the name of *Cecropia*, and acquired that of *Athens*, on what account is not certain; the moſt probable is, that it was ſo named in reſpect to the goddeſs Minerva, whom the Greeks call *Athene*, who was alſo eſteemed its protectreſs. This old city was ſeated on the top of a rock in the midſt of a large and pleaſant plain, which, as the number of inhabitants increaſed, became full of buildings, which induced the diſtinction of Acro and Catapolis, *i. e.* of the upper and lower city. The extent of the citadel was 60 ſtadia; it was ſurrounded by olive trees, and fortified, as ſome ſay, with a ſtrong paliſade; in ſucceeding times it was encompaſſed with a ſtrong wall, in which there were nine gates, one very large one, and the reſt ſmall. The inſide of the citadel was adorned with innumerable edifices. The moſt remarkable of which were, 1. The magnificent temple of Minerva, ſtyled *parthenion*, becauſe that goddeſs was a virgin. The Perſians deſtroyed it; but it was rebuilt with ſtill greater ſplendor by the famous Pericles, all of the fineſt marble, with ſuch ſkill and ſtrength, that, in ſpite of the rage of time and barbarous nations, it remains perhaps the firſt antiquity in the world, and ſtands a witneſs to the truth of what ancient writers have recorded of the prodigious magnificence of Athens in her flouriſhing ſtate. 2. The temple of Neptune and of Minerva; for it was divided into two parts: one ſacred to the god, in which was the ſalt fountain ſaid to have ſprung upon the ſtroke of his trident; the other to the goddeſs protectreſs of Athens, wherein was the ſacred olive which ſhe produced, and her image which fell down from heaven in the reign of Erichthonius. At the back of Minerva's temple was the public treaſury, which was burnt to the ground through the knavery of the treaſurers, who, having miſapplied the revenues of the ſtate, took this ſhort method of making up accounts. Athens: 2 Remarkable buildings.

The lower city comprehended all the buildings ſurrounding the citadel, the fort Munychia, and the havens Phalerum and Piræus, the latter of which was joined to the city by walls five miles in length; that on the north was built by Pericles, but that on the ſouth by Themiſtocles; but by degrees the turrets which were at firſt erected on thoſe walls were turned into dwelling-houſes for the accommodation of the Athenians, whoſe large city was now become too ſmall for them. The city, or rather the lower city, had 13 great gates, with the names of which it is not neceſſary to trouble the reader. Among the principal edifices which adorned it, we may reckon, 1. The temple of Theſeus, erected by Conon, near its centre. Adjacent thereto, the young people performed their exerciſes. It was alſo a ſanctuary for diſtreſſed perſons, ſlaves or free. 2. The Olympian temple erected in honour of Jupiter, the honour of Athens, and of all Greece. The foundation of it was laid by Piſiſtratus: it was carried on but ſlowly in ſucceeding times, 700 years elapſing before it was finiſhed, which happened under the reign of Adrian, who was particularly kind to Athens: this was the firſt building in which the Athenians beheld pillars. 3. The pantheon, dedicated to all the gods; a moſt noble ſtructure, ſupported by 120 marble pillars, and having over its great gate two horſes carved by Praxiteles: it is yet remaining, as we ſhall have occaſion to ſhow hereafter when we come to ſpeak of the preſent ſtate of this famous city. In ſeveral parts of it were *ſtaoi* or porticos, wherein people walked in rainy weather, and from whence a ſect of philoſophers were denominated *ſtoics*, becauſe their maſter Zeno taught in thoſe porticos.

3 Ceramicus.

There were at Athens two places called *Ceramicus*, from Ceramus the ſon of Bacchus and Ariadne; one within the city, containing a multitude of buildings of all ſorts; the other in the ſuburbs, in which was the academy and other edifices. The Gymnaſia of Athens were many; but the moſt remarkable were the Lyceum, Academia, and Cynoſarges. The Lyceum ſtood on the banks of Iliſſus; ſome ſay it was built by Piſiſtratus, others by Pericles, others by Lycurgus. Here Ariſtotle taught philoſophy, inſtructing ſuch as came

to

Athens. to hear him as they walked, whence his diſciples are generally thought to derive the name of *peripatetics*. The ceramicus without the city was the diſtance of ſix ſtadia from its walls. The academy made part thereof; as to the name of which there is ſome diſpute. Some affirm that it was ſo called from Academus, an ancient hero, who, when Helen was ſtolen by Theſeus, diſcovered the place where ſhe lay hid to Caſtor and Pollux: for which reaſon the Lacedemonians, when they invaded Attica always ſpared this place. Dicæarchus writes, that Caſtor and Pollux had two Arcadians in their army, the one named *Echedemus*, the other *Marathus*; from the former of theſe he ſays this place took its name, and that the borough of Marathon was ſo called from the other. It was a marſhy unwholeſome place, till Cimon was at great pains to have it drained; and then it became extremely pleaſant and delightful, being adorned with ſhady walks, where Plato read his lectures, and from thence his ſcholars were ſtyled *academics*.

4 Cynoſarges. The Cynoſarges was a place in the ſuburbs not far from the Lyceum: it was famous on many accounts; but particularly for a noble gymnaſium erected there, appointed for the ſpecial uſe of ſuch as were Athenians only by one ſide. In after times Themiſtocles derived to himſelf ill-will, by carrying many of the nobility to exerciſe with him here, becauſe, being but of the half blood, he could exerciſe no where elſe but in this gymnaſium. Anthiſthenes inſtituted a ſect of philoſophers, who from the name of this diſtrict, as many think, were ſtyled *Cynics*.

5 Havens. The havens of Athens were three. Firſt the Pyræus, which was diſtant about 35 or 40 ſtadia from the city, till joined thereto by the long walls beforementioned, after which it became the principal harbour of the city, It had three docks; Cantharos, Aphrodiſium, and Zea: the firſt was ſo called from an ancient hero, the ſecond from the goddeſs Venus who had there two temples, and the third from bread-corn. There were in this port five porticos, which joining together formed one great one called from thence *Macra Stoa*, or the grand portico. There were likewiſe two great markets or fora; one near the long portico, the other near the city. The ſecond port was Munichia, a promontory not far diſtant from Pyræus; a place very ſtrong by nature, and afterwards rendered far ſtronger by art. It was of this that Epimenides ſaid, if the Athenians foreſaw what miſchief it would one day produce to them, they would eat it away with their teeth. The third was Phalerum, diſtant from the city, according to Thucydides 35 ſtadia, but according to Pauſanias only 20. This was the moſt ancient harbour of Athens, as Pyræus was the moſt capacious.

6 Preſent ſtate. Of this city, as it ſtands at preſent, we have the following account by Dr Chandler. "It is now called *Athini*; and is not inconſiderable, either in extent or the number of inhabitants. It enjoys a fine temperature, and ſerene ſky. The air is clear and wholeſome, though not ſo delicately ſoft as in Ionia. The town ſtands beneath the Archopolis or citadel; not encompaſſing the rock as formerly, but ſpreading into the plain, chiefly on the weſt and north-weſt. Corſairs infeſting it, the avenues were ſecured, and in 1676 the gates were regularly ſhut after ſunſet. It is now open again; but ſeveral of the gateways remain, and a guard of Turks patrols at midnight. Some maſſes of brick work, ſtanding ſeparate, without the town, belonged perhaps to the ancient wall, of which other traces alſo appear. The houſes are moſtly mean and ſtraggling; many with large areas or courts before them. In the lanes, the high walls on each ſide, which are commonly whitewaſhed, reflect ſtrongly the heat of the ſun. The ſtreets are very irregular; and anciently were neither uniform nor handſome. They have water conveyed in channels from mount Hymettus, and in the bazar or market-place is a large fountain. The Turks have ſeveral moſques and public baths. The Greeks have convents for men and women; with many churches, in which ſervice is regularly performed; and beſides theſe, they have numerous oratories or chapels, ſome in ruins or conſiſting of bare walls, frequented only on the anniverſaries of the ſaints to whom they are dedicated. A portrait of the owner on a board is placed in them on that occaſion, and removed when the ſolemnity of the day is over.

7 Citadel, or city of Cecrops. "The city of Cecrops is now a fortreſs with a thick irregular wall, ſtanding on the brink of precipices, and incloſing a large area about twice as long as broad. Some portions of the ancient wall may be diſcovered on the outſide, particularly at the two extreme angles; and in many places it is patched with pieces of columns, and with marbles taken from the ruins. A conſiderable ſum had been recently expended on the ſide next Hymettus, which was finiſhed before we arrived. The ſcaffolding had been removed to the end toward Pentele; but money was wanting, and the workmen were withdrawn. The garriſon conſiſts of a few Turks, who reſide there with their families, and are called by the Greeks *Caſtriani*, or the ſoldiers of the caſtle. The rock is lofty, abrupt, and inacceſſible, except the front, which is towards the Piræus; and on that quarter is a mountainous ridge, within cannon-ſhot. It is deſtitute of water fit for drinking; and ſupplies are daily carried up in earthen jars, on horſes and aſſes, from one of the conduits in the town.

"The acropolis furniſhed a very ample field to the ancient virtuoſi. It was filled with monuments of Athenian glory, and exhibited an amazing diſplay of beauty, of opulence, and of art; each contending as it were for the ſuperiority. It appeared as one entire offering to the Deity, ſurpaſſing in excellence and aſtoniſhing in richneſs. Heliodorus, named Periegetes *the guide*, had employed on it 15 books. The curioſities of various kinds, with the pictures, ſtatues, and pieces of ſculpture, were ſo many and ſo remarkable, as to ſupply Polemo Periegetes with matter for four volumes; and Strabo affirms, that as many would be required in treating of other portions of Athens and of Attica. In particular, the number of ſtatues was prodigious. Tiberius Nero, who was fond of images, plundered the acropolis as well as Delphi and Olympia; yet Athens, and each of theſe places, had not fewer than 3000 remaining in the time of Pliny. Even Pauſanias ſeems here to be diſtreſſed by the multiplicity of his ſubject. But this banquet, as it were, of the ſenſes has long been withdrawn; and is now become like the tale of a viſion. The ſpectator views with concern the marble ruins interminxed with mean flat-roofed cottages, and extant amid rubbiſh; the ſad memorials of a nobler people; which, however, as viſible from the ſea, ſhould have introduced modern Athens

Athens. thens to more early notice. They who reported it was only a ſmall village, muſt, it has been ſurmiſed, have beheld the acropolis through the wrong end of their teleſcopes.

" The acropolis has now, as formerly, only one entrance, which fronts the Piræus. The aſcent is by traverſes and rude fortifications furniſhed with cannon, but without carriages, and neglected. By the ſecond gate is the ſtation of the guard, who ſits croſs-legged under cover, much at his eaſe, ſmoking his pipe, or drinking coffee, with his companions about him in like attitudes. Over this gate-way is an inſcription in large characters on a ſtone turned upſide down, and black from the fires made below. It records a preſent of a pair of gates.

8 Propyléa. " Going farther up, you come to the ruins of the propyléa, an edifice which graced the entrance into the citadel. This was one of the ſtructures of Pericles, who began it when Euthymenes was archon, 435 years before Chriſt. It was completed in five years, at the expence of 2012 talents. It was of marble, of the Doric order, and had five doors to afford an eaſy paſſage to the mulitudes which reſorted on buſineſs or devotion to the acropolis.

" While this fabric was building, the architect Mneſicles, whoſe activity equalled his ſkill, was hurt by a fall, and the phyſicians deſpaired of his life; but Minerva, who was propitious to the undertaking, appeared, it was ſaid, to Pericles, and preſcribed a remedy, by which he was ſpeedily and eaſily cured. It was a plant or herb growing round about the acropolis, and called afterwards *parthenium*.

9 Temple of Victory. " The right wing of the propyléa was a temple of Victory. They related that Ægeus had ſtood there, viewing the ſea, and anxious for the return of his ſon Theſeus, who was gone to Crete with the tributary children to be delivered to the Minotaur. The veſſel which carried them had black ſails ſuiting the occaſion of its voyage; and, it was agreed, that, if Theſeus overcame the enemy, their colour ſhould be changed to white. The neglect of this ſignal was fatal to Ægeus, who, on ſeeing the ſails unaltered, threw himſelf down headlong from the rock, and periſhed. The idol was named *Victory without wings*; it was ſaid, becauſe the news of the ſucceſs of Theſeus did not arrive but with the conqueror. It had a pomegranate in the right hand, and an helmet in the left. As the ſtatue was without pinions, it was hoped the goddeſs would remain forever on the ſpot.

" On the left wing of the propyléa, and fronting the temple of Victory, was a building decorated with paintings by Polygnotus, of which an account is given by Pauſanias. This edifice, as well as the temple, was of the Doric order, the columns fluted, and without baſes. Both contributed alike to the uniformity and grandeur of the deſign; and the whole fabric, when finiſhed, was deemed equally magnificent and ornamental. The interval between Pericles and Pauſanias conſiſts of ſeveral centuries. The propyléa remained entire in the time of this topographer; and, as will be ſhown, continued nearly ſo to a much later period. It had then a roof of white marble, which was unſurpaſſed either in the ſize of the ſtones or in the beauty of their arrangement; and before each wing was an equeſtrian ſtatue.

Athens. " The propyléa have ceaſed to be the entrance of the acropolis. The paſſage, which was between the columns in the centre, is walled up almoſt to their capitals, and above is a battery of cannon. The way now winds before the front of the ancient ſtructure; and turning to the left hand among rubbiſh and mean walls, you come to the back part, and to the five door-ways. The ſoil without is riſen higher than the top of the two ſmaller. There, under the vault and cannon, lies an heap of large ſtones, the ruin of the roof.

" The temple of Victory, ſtanding on an abrupt rock, has its back and one ſide encumbered with the modern ramparts. The columns in the front being walled up, you enter it by a breach in the ſide, within the propyléa. It was uſed by the Turks as a magazine for powder, until about the year 1656, when a ſudden exploſion, occaſioned by lightning, carried away the roof, with a houſe erected on it, belonging to the officer who commanded in the acropolis, whoſe family, except a girl, periſhed. The women of the Aga continued to inhabit in this quarter, but it is now abandoned and in ruins.

10 Roof carried off by an exploſion.

" The cell of the temple of Victory, which is of white marble, very thick, and ſtrongly cemented, ſufficiently witneſſes the great violence it has undergone; the ſtones in many places being disjointed, as it were, and forced from their original poſition. Two of theſe making an acute angle, the exterior edges touching, without a crevice; and the light abroad being much ſtronger than in the room, which has a modern roof and is dark; the portion in contact becoming pellucid, had illumined the vacant ſpace with a dim colour reſembling that of amber. We were deſired to examine this extraordinary appearance, which the Greeks regarded as a ſtanding miracle, and which the Turks, who could not confute them, beheld with equal aſtoniſhment. We found in the gape ſome coals, which had been brought on a bit of earthen ware for the purpoſe of burning incenſe, as we ſuppoſed, and alſo a piece of wax-taper, which probably had been lighted in honour of the ſaint and author of the wonder; but our Swiſs unfortunately carrying his own candle too far in, the ſmoke blackened the marble, and deſtroyed the phenomenon.

" The building oppoſite to the temple has ſerved as a foundation for a ſquare lofty tower of ordinary maſonry. The columns of the front are walled up; and the entrance is by a low iron gate in the ſide. It is now uſed as a place of confinement for delinquents; but in 1676 was a powder magazine. In the wall of a rampart near it are ſome fragments of exquiſite ſculpture, repreſenting the Athenians fighting with the Amazons. Theſe belong to the freeze, which was then ſtanding. In the ſecond century, when Pauſanias lived, much of the painting was impaired by age, but ſome remained, and the ſubjects were chiefly taken from the Trojan ſtory. The traces are ſince vaniſhed.

" The pediment of the temple of Victory, with that of the oppoſite wing, is deſcribed as remaining in 1676, but on each building a ſquare tower had been erected. One of the ſteps in the front of the propyléa was entire, with the four columns, their entablature and the pediment. The portico, to which the five doorways belonged, conſiſted of a large ſquare room, roof-

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Athens. ed with ſlabs of marble, which were laid on two great marble beams, and ſuſtained by four beautiful columns. Theſe were Ionic, the proportions of this order beſt ſuiting that purpoſe, as taller than the Doric; the reaſon it was likewiſe preferred in the pronaos of the temple of Victory. The roof of the propyléa, after ſtanding above 2000 years, was probably deſtroyed, with all the pediments, by the Venetians in 1687, when they battered the caſtle in front, firing red-hot bullets, and took it, but were compelled to reſign it again to the Turks in the following year. The exterior walls, and in particular, a ſide of the temple of Victory, retain many marks of their hoſtilities.

11 Temple of Minerva. "The chief ornament of the acropolis was the parthenion or great temple of Minerva, a moſt ſuperb and magnificent fabric. The Perſians had burned the edifice, which before occupied the ſite, and was called *hecatompedon*, from its being 100 feet ſquare. The zeal of Pericles and of all the Athenians was exerted in providing a far more ample and glorious reſidence for their favourite goddeſs. The architects were Callicrates and Ictinus; and a treatiſe on the building was written by the latter and Carpion. It was of white marble, of the Doric order, the columns fluted and without baſes, the number in front eight: and adorned with admirable ſculpture. The ſtory of the birth of Minerva was carved in the front pediment; and in the back, her conteſt with Neptune for the country. The beaſts of burden, which had conveyed up the materials, were regarded as ſacred, and recompenſed with paſtures; and one, which had voluntarily headed the train, was maintained during life, without labour, at the public expence.

12 Her ſtatue. "The ſtatue of Minerva, made for this temple by Phidias, was of ivory, 26 cubits or 39 feet high. It was decked with pure gold to the amount of 44 talents, ſo diſpoſed by the advice of Pericles as to be taken off and weighed if required. The goddeſs was repreſented ſtanding, with her veſtment reaching to her feet. Her helmet had a ſphinx for the creſt, and on the ſides were griffins. The head of Meduſa was on her breaſt-plate. In one hand ſhe held her ſpear, and in the other ſupported an image of Victory about four cubits high. The battle of the Centaurs and Lapithæ was carved on her ſandals; and on her ſhield, which lay at her feet, the war of the gods and giants, and the battle of the Athenians and Amazons. By her ſpear was a ſerpent, in alluſion to the ſtory of Erichthonius; and on the pedeſtal, the birth of Pandora. The Sphinx, the Victory, and Serpent, were accounted eminently wonderful. This image was placed in the temple in the firſt year of the 87th Olympiad, in which the Peloponneſian war began. The gold was ſtripped off by the tyrant Lachares, when Demetrius Poliorcetes compelled him to fly. The ſame plunderer plucked down the golden ſhields in the acropolis, and carried away the golden Victories, with the precious veſſels and ornaments provided for the Panathenæan feſtival.

"The parthenion remained entire for many ages after it was deprived of the goddeſs. The Chriſtians converted it into a church, and the Mahometans into a moſque. It is mentioned in the letters of Cruſius, and miſcalled the *pantheon*, and the *temple of the unknown God*. The Venetians under Koningſmark, when they beſieged the acropolis in 1687, threw a bomb, which demoliſhed the roof, and ſetting fire to ſome powder, did much damage to the fabric. The floor, which is indented, ſtill witneſſes the place of its fall. This was the ſad forerunner of farther deſtruction; the Turks, breaking the ſtones, and applying them to the building of a new moſque, which ſtands within the ruin, or to the repairing of their houſes and the walls of the fortreſs. The vaſt pile of ponderous materials, which lay ready, is greatly diminiſhed; the whole ſtructure will gradually be conſumed and diſappear. Athens.

13 Temple converted into a moſque. "The temple of Minerva in 1676 was, as Wheeler and Spon aſſert, the fineſt moſque in the world, without compariſon. The Greeks had adapted the fabric to their ceremonial by conſtructing at one end a ſemicircular receſs for the holy tables, with a window: for before it was enlightened only by the door, obſcurity being preferred under the heathen ritual, except on feſtivals, when it yielded to ſplendid illuminations; the reaſon, it has been ſurmiſed, why temples are commonly found ſimple and unadorned on the inſides. In the wall beneath the window were inſerted two pieces of the ſtone called *phengites*, a ſpecies of marble diſcovered in Cappadocia in the time of Nero; and ſo tranſparent that he erected with it a temple to Fortune, which was luminous within, when the door was ſhut. Theſe pieces were perforated, and the light which entered was tinged with a reddiſh or yellowiſh hue. The picture of the Panagia or Virgin Mary, in Moſaic, on the ceiling of the receſs, remained; with two jaſper columns belonging to the ſcreen, which had ſeparated that part from the nave; and within, a canopy ſupporte d by four pillars of porphyry, with Corinthian capitals of white marble, under which the table had been placed; and behind it, beneath the window, a marble chair for the archbiſhop; and alſo a pulpit, ſtanding on four ſmall pillars in the middle aile. The Turks had white-waſhed the walls to obliterate the portraits of ſaints, and the other paintings, with which the Greeks decorate their places of worſhip; and had erected a pulpit on the right hand for their iman or reader. The roof was diſpoſed in ſquare compartments; the ſtones maſſive: and ſome had fallen in. It had been ſuſtained in the pronaos by ſix columns; but the place of one was then ſupplied by a large pile of rude maſonry, the Turks not having been able to fill up the gap more worthily. The roof of the naos was ſupported by colonnades ranging with the door, and on each ſide; conſiſting of 22 pillars below, and of 23 above. The odd one was over the entrance, which by that diſpoſition was left wide and unembarraſſed. In the portico were ſuſpended a few lamps, to be uſed in the moſque at the ſeaſons when the muſſelmans aſſemble before day-break, or to be lighted up round the minaret, as is the cuſtom during their Ramazan or Lent.

14 Magnificent ruin. "It is not eaſy to conceive a more ſtriking object than the parthenion, though now a mere ruin. The columns within the naos have all been removed: but on the floor may be ſeen the circles which directed the workmen in placing them; and at the farther end is a groove acroſs it, as for one of the partitions of the cell. The receſs erected by the Chriſtians is demoliſhed; and from the rubbiſh of the ceiling the Turkiſh

boys

Athens. boys collect bits of the Moſaic, of different colours, which compoſed the picture. We are told at Smyrna, that this ſubſtance had taken a poliſh, and been ſet in buckles. This cell is about half demoliſhed; and in the columns which ſurround it, is a large gap near the middle. On the walls are ſome traces of the paintings. Before the portico is a reſervoir ſunk in the rock, to ſupply the Turks with water for the purifications cuſtomary on entering their moſques. In it, on the left hand, is the rubbiſh of the pile erected to ſupply the place of a column; and on the right, a ſtaircaſe, which leads out on the architrave, and has a marble or two with inſcriptions, but worn ſo as not to be legible. It belonged to the minaret, which has been deſtroyed.

15 Sculptures. "The travellers, to whom we are indebted for an account of the moſque, have likewiſe given a deſcription of the ſculpture then remaining in the front. In the middle of the pediment was ſeen a bearded Jupiter, with a majeſtic countenance, ſtanding, and naked; the right arm broken. The thunderbolt, it has been ſuppoſed, was placed in that hand, and the eagle between his feet. On his right was a figure, it is conjectured, of Victory, clothed to the mid-leg; the head and arms gone. This was leading on the horſes of a car, in which Minerva ſat, young and unarmed; her headdreſs, inſtead of a helmet, reſembling that of a Venus. The generous ardour and lively ſpirit viſible in this pair of celeſtial ſteeds, was ſuch as beſpoke the hand of a maſter, bold and delicate, of a Phidias or Praxiteles. Behind Minerva was a female figure, without a head, ſitting, with an infant in her lap; and in this angle of the pediment was the emperor Hadrian with his arm round Sabina, both reclining, and ſeeming to regard Minerva with pleaſure. On the left ſide of Jupiter were five or ſix other trunks to complete the aſſembly of deities, into which he received her. Theſe figures were all wonderfully carved, and appeared as big as life. Hadrian and his conſort, it is likely, were complimented by the Athenians with places among the marble gods in the pediment, as benefactors. Both of them may be conſidered as intruders on the original company; and poſſibly their heads were placed on trunks, which before had other owners. They ſtill poſſeſs their corner, and are eaſy to be recogniſed, though not unimpaired. The reſt of the ſtatues are defaced, removed, or fallen. Moroſini was ambitious to enrich Vence with the ſpoils of Athens; and by an attempt to take down the principal group, haſtened their ruin. In the other pediment is a head or two of ſea-horſes finely executed, with ſome mutilated figures; and on the architrave beneath them are marks of the fixtures of votive offerings, perhaps of the golden ſhields, or of feſtoons ſuſpended on ſolemn occaſions, when the temple was dreſſed out to receive the votaries of the goddeſs.

16 Erectheum. "Neptune and Minerva, once rival deities, were joint and amicable tenants of the Erectheum, in which was an altar of Oblivion. The building was double, a partition-wall dividing it into two temples, which fronted different ways. One was the temple of Neptune Erectheus, the other of Minerva Polias. The latter was entered by a ſquare portico connected with a marble ſkreen, which fronts towards the propyléa. The door of the cell was on the left hand; and at the farther end of the paſſage was a door leading down into the Pandroſéum, which was contiguous. Athens.

17 Temple of Neptune Erectheus. "Before the temple of Neptune Erectheus was an altar of Jupiter *the ſupreme*, on which no living thing was ſacrificed, but they offered cakes without wine. Within it was the altar of Neptune and Erectheus; and two, belonging to Vulcan and a hero named *Butes*, who had tranſmitted the prieſthood to his poſterity, which were called *Butadæ*. On the walls were paintings of this illuſtrious family, from which the prieſteſs of Minerva Polias was alſo taken. It was aſſerted that Neptune had ordained the well of ſalt water, and the figure of a trident in the rock, to be memorials of his contending for the country. The former, Pauſanias remarks, was no great wonder, for other wells of a ſimilar nature were found inland; but this, when the ſouth wind blew, afforded the ſound of waves.

18 Of Minerva Polias. "The temple of Minerva Polias was dedicated by all Attica, and poſſeſſed the moſt ancient ſtatue of the goddeſs. The demi or towns had other deities, but their zeal for her ſuffered no diminution. The image, which they placed in the acropolis, then the city, was in after ages not only reputed conſummately holy, but believed to have fallen down from heaven in the reign of Erichthonius. It was guarded by a large ſerpent, which was regularly ſerved with offerings of honied cakes for his food. This divine reptile was of great ſagacity, and attained to an extraordinary age. He wiſely withdrew from the temple, when in danger from the Medes; and, it is ſaid, was living in the ſecond century. Before this ſtatue was an owl; and a golden lamp. This continued burning day and night. It was contrived by a curious artiſt, named *Callimachus*, and did not require to be repleniſhed with oil oftener than once a-year. A brazen palm-tree, reaching to the roof, received its ſmoke. Ariſtion had let the holy flame expire while Sylla beſieged him, and was abhorred for his impiety. The original olive-tree, ſaid to have been produced by Minerva, was kept in this temple. When the Medes ſet fire to the acropolis, it was conſumed; but, they aſſerted, on the following day, was found to have ſhot up again as much as a cubit. It grew low and crooked, but was eſteemed very holy. The prieſteſs of Minerva was not allowed to eat of the new cheeſe of Attica; and, among her perquiſites, was a meaſure of wheat, and one of barley, for every birth and burial. This temple was again burned when Callias was archon, 24 years after the death of Pericles. Near it was the tomb of Cecrops, and within it Erectheus was buried.

"The ruin of the Erectheum is of white marble; the architectural ornaments of very exquiſite workmanſhip, and uncommonly curious. The columns of the front of the temple of Neptune are ſtanding with the architrave; and alſo the ſkreen and portico of Minerva Polias, with a portion of the cell retaining traces of the partition-wall. The order is Ionic. An edifice revered by ancient Attica, as holy in the higheſt degree, was in 1676 the dwelling of a Turkiſh family, and is now deſerted and neglected; but many ponderous ſtones and much rubbiſh muſt be removed before the well and trident would appear. The former, at leaſt, might probably be diſcovered. The portico is uſed as a powder-magazine; but we obtained permiſ-

Athens. Athens, Atherina.

sion to dig and to examine the outside. The door-way of the vestibule is walled up, and the soil risen nearly to the top of the door-way of the Pandroséum. By the portico is a battery commanding the town, from which ascends an amusing hum. The Turks fire from it, to give notice of the commencement of Ramazan or of their Lent, and of bairam or the holy-days, and on other public occasions.

"The pandroséum is a small, but very particular building, of which no satisfactory idea can be communicated by description. The entablature is supported by women called *Caryatides*. Their story is thus related. The Greeks, victorious in the Persian war, jointly destroyed Carya, a city of the Peloponnesus, which had favoured the common enemy. They cut off the males, and carried into captivity the women, whom they compelled to retain their former dress and ornaments, though in a state of servitude. The architects of those times, to perpetuate the memory of their punishment, represented them, as in this instance, each with a burden on her head, one hand uplifted to it; and the other hanging down by her side. The images were in number six, all looking toward the parthenion. The four in front, with that next to the propyléa, remain, but mutilated, and their faces besmeared with paint. The soil is risen almost to the top of the basement on which they are placed. This temple was open or latticed between the statues; and in it also was a stunted olive-tree, with an altar of Jupiter Hercéus standing under it. The propyléa are nearly in a line with the space dividing it from the parthenion; which disposition, besides its other effects, occasioned the front and flank of the latter edifice to be seen at once by those who approached it from the entrance of the acropolis.

19 Of Jupiter Olympius.

"The ruin of the temple of Jupiter Olympius consists of prodigious columns, tall and beautiful, of the Corinthian order, fluted; some single, some supporting their architraves; with a few massive marbles beneath; the remnant of a vast heap, which only many ages could have consumed and reduced into so scanty a compass. The columns are of very extraordinary dimensions, being about six feet in diameter, and near 60 in height. The number without the cell was 116 or 120. Seventeen were standing in 1676: but a few years before we arrived, one was overturned with much difficulty, and applied to the building a new mosque in the bazar or market-place. This violence was avenged by the bashaw of Negropont, who made it a pretext for extorting from the vaiwode or governor 15 purses; the pillar being, he alleged, the property of their master the Grand Signior. It was an angular column, and of consequence in determining the dimensions of the fabric. We regretted that the fall of this mighty mass had not been postponed until we came, as it would have afforded an opportunity of inspecting and measuring some members which we found far too lofty to be attempted. On a piece of the architrave, supported by a couple of columns, are two parallel walls, of modern masonry, arched about the middle, and again near the top. You are told it has been the habitation of a hermit, doubtless of a Stylites; but of whatever building it has been part, and for whatever purpose designed, it must have been erected thus high in air, while the immense ruin of this huge structure was yet scarcely diminished, and the heap inclined so as to render it accessible. It was remarked that two stones of a step in the front had coalesced at the extremity, so that no juncture could be perceived; and the like was discovered also in a step of the parthenion. In both instances it may be attributed to a concretory fluid, which pervades the marble in the quarry. Some portion remaining in the pieces, when taken green as it were, and placed in mutual contact, it exsuded and united them by a process similar to that in a bone of an animal when broken and properly set.

20 Detached pieces of antique sculpture, &c.

"Besides the more stable antiquities, many detached pieces are found in the town, by the fountains, in the streets, the walls, the houses, and churches. Among these are fragments of sculpture; a marble chair or two, which probably belonged to the Gymnasia or theatres: a sun-dial at the catholicon or cathedral, inscribed with the name of the maker; and, at the archiepiscopal house close by, a very curious vessel of marble, used as a cistern to receive water, but once serving, it is likely, as a public standard or measure. Many columns occur; with some maimed statues, and pedestals, several with inscriptions, and almost buried in earth. A custom has prevailed, as at Chios, of fixing in the wall, over the gate-ways and doors of the houses, carved stones, most of which exhibit the funeral supper. In the courts of the houses lie many round stelæ, or pillars, once placed on the graves of the Athenians; and a great number are still to be seen applied to the same use in the Turkish burying grounds before the acropolis. These generally have concise inscriptions containing the name of the person, and of the town and tribe to which the deceased belonged. Demetrius the Phalerian, who endeavoured to restrain sepulchral luxury, enacted, that no person should have more than one, and that the height should not exceed three cubits. Another species, which resembles our modern head-stones, is sometimes adorned with sculpture, and has an epitaph in verse. We saw a few mutilated Hermæ. These were busts on long quadrangular bases, the heads frequently of brass, invented by the Athenians. At first they were made to represent only Hermes or Mercury, and designed as guardians of the sepulchres in which they were lodged; but afterwards the houses, streets, and porticos of Athens, were adorned with them, and rendered venerable by a multitude of portraits of illustrious men and women, of heroes, and of gods: and, it is related, Hipparchus, son of Pisistratus, erected them in the demi or burough-towns, and by the road-side, inscribed with moral apophthegms in elegiac verse; thus making them vehicles of instruction."

ATHERINA, in ichthyology, a genus of fishes of the order of abdominales. The characters of this genus are these: The upper jaw is plain: the rays of the branchiostege membrane are six; and the side-belt or line shines like silver. The species are two, viz. 1. The hepsetus, with about 12 rays in the fin next the anus. It is found in the Mediterranean. It is also very common in the sea near Southampton, England, where, it is called a *smelt*. The highest season is from March to the latter end of May, or beginning of June; in which month it spawns. It never deserts the place; and is constantly taken except in hard frost. It is also found on other coasts of that island. The length is a-

bove

Atheroma] Athletic.

bove 4½ inches, and the tail is much forked. The fiſh is ſemipellucid, covered with ſcales; the colour ſilvery, tinged with yellow: beneath the ſide-line is a row of ſmall black ſpots. 2. The menidea, with 24 rays in the fin next the anus. This is a very ſmall pellucid fiſh, with many black points interſperſed; it has many teeth in the lips, but none in the tongue or jaws. It is found in the freſh waters of Carolina, and ſpawns in April.

ATHEROMA, in ſurgery, a tumor without pain or diſcoloration of the ſkin, containing, in a membranous bag, matter reſembling pap, intermixed with hard and ſtony particles. Theſe tumors are eaſily cured by inciſion.

ATHERTON, or ATHERSTON, a town of Warwickſhire in England, ſituated on the river Stour, in W. Long. 1. 30. N. Lat. 52. 40. It is a conſiderable town, and had formerly a monaſtery; but now is beſt known by its fair, which is the greateſt in England for cheeſe.

ATHESIS (anc. geog.), a river of the Ciſalpine Gaul, which, riſing in the Rhetian Alps, in Mount Brenna, in the county of Tirol, runs ſouthwards and waſhes Tridentum and Verona, which laſt it divides; and after paſſing this, bends its courſe eaſtwards, in a parallel direction with the Po, and falls into the Adriatic between Foſſa Claudia and Philiſtina: it ſeparated the Euganei, an ancient people, from the Veneti. The people dwelling on it are called *Atheſini* (Pliny). Its modern name is the *Adige*.

ATHLETÆ, in antiquity, perſons of ſtrength and agility, diſciplined to perform in the public games. The word is originally Greek, αθλητης; formed from αθλος, *certamen*, "combat;" whence alſo αθλον, the prize or reward adjudged the victor.—Under Athletæ were comprehended wreſtlers, boxers, runners, leapers, throwers of the diſk, and thoſe practiſed in other exerciſes exhibited in the Olympic, Pythian, and other ſolemn ſports; for the conquerors wherein there were eſtabliſhed prizes.

ATHLETIC HABIT, denotes a ſtrong hale conſtitution of body. Anciently it ſignified a full fleſhy corpulent ſtate, ſuch as the athletæ endeavoured to arrive at. The athletic habit is eſteemed the higheſt pitch of health: yet is it dangerous, and the next door to diſeaſe; ſince, when the body is no longer capable of being improved, the next alteration muſt be for the worſe. The chief object of the athletic diet, was to obtain a firm, bulky, weighty body; by force of which, more than art and agility, they frequently overpowered their antagoniſt: hence they fed altogether on dry ſolid, and viſcuous meats. In the earlier days, their chief food was dry figs and cheeſe, which was called *arida ſaginatio* ξηρα τροφη, and Ασκησις διαξηρων ισχαδων. Oribaſius, or, as others ſay, Pythagoras, firſt brought this in diſuſe, and ſubſtituted fleſh in lieu thereof. They had a peculiar bread called κολλυπια: They exerciſed, eat, and drank, without ceaſing: they were not allowed to leave off eating when ſatiated, but were obliged to cram on till they could hold no more; by which means they at length acquired a degree of voracity which to us ſeems incredible, and a ſtrength proportional. Witneſs what Pauſanias relates of the four celebrated athletæ, Polydamus the Theſſalian, Milo the Crotonian, Theagenes the Thaſian, and Euthymus the Locrian: The ſecond is ſaid to have carried a bull on his back a conſiderable way, then to have knocked him down with a blow of his fiſt, and laſtly, as ſome add, devoured him at a meal.

Athlone ‖ Athos.

ATHLONE, a town of Weſtmeath, in Ireland, lying in W. Long. 8. 0. N. Lat. 53. 20. It is ſituated on both ſides of the Shannon, and both parts are united by a ſtrong, high-raiſed, and well-built bridge, in the middle of which ſtands a monument, with ſome figures cut in marble, together with Queen Elizabeth's arms, and ſome inſcriptions declaring the time and the founders of the building. The caſtle was founded by King John on ſome land belonging to St Peter's abbey, for which he granted a compenſation. It is built on a high-raiſed round hill, reſembling one of the Daniſh raths or forts. Here were formerly two convents or monaſteries. Athlone was formerly ſtrongly fortified, and conſidered as of very great importance. In the year 1691, a part of the Engliſh army under General Ginckle, in the very face of the Iriſh, who were ſtrongly entrenched on the oppoſite ſhore, fording the river, formed, and took poſſeſſion of the town, not loſing more than 50 men in the attack; which is eſteemed as bold and ſucceſsful an enterpriſe as any recorded in hiſtory. There are generally two troops of horſe and four companies of foot quartered at Athlone. This town gives the title of *earl* to the family of Ginckle, as a reward for the noble ſervices performed by the General.

ATHOL, the moſt northern diſtrict of Perthſhire in Scotland, extending in length 43 miles, and in breadth 30. It is bordered on the north by Badenoch, on the weſt by Lochaber, on the eaſt and ſouth-eaſt by Mar and Gowrie, on the ſouth by Stratherne and Perth Proper, and on the ſouth-weſt by Braidalbane. The country is very rough and mountainous, and contains part of the ancient Caledonian foreſt; but theſe mountains are interſperſed with fruitful vallies. Here are ſeveral villages, but no towns of any conſideration. The moſt noted place is Blair Caſtle, ſeated on the river Tilt, near its influx into the Gurrey, a pleaſant limpid ſtream that falls into the Tay. This caſtle belongs to the Duke of Athol, who derives his title from this diſtrict, and lives here with great magnificence. In the ſame neighbourhood we ſee the paſs of Gillicranky, rendered memorable by the battle fought here in the beginning of King William's reign, between that monarch's general M'Kay, and the Highlanders adhering to king James. See GILLICRANKY.

ATHOS, a celebrated mountain of Chalcidia in Macedonia, ſituated E. Long. 26. 20. N. Lat. 40. 10. The ancients entertained extravagant notions concerning its height. Mela affirmed it to be ſo high as to reach above the clouds; and Martianus Capellinus, that it was ſix miles high. It was a received opinion, that the ſummit of mount Athos was above the middle region of the air, and that it never rained there; becauſe the aſhes left on the altars erected near its ſummit were always found as they were left, dry and unſcattered. But if on many accounts it was famous among the ancients, it is no leſs ſo among the moderns. The Greeks, ſtruck with its ſingular ſituation and the venerable appearance of its towering aſcent, erected ſo many churches, monaſteries, hermitages, &c. upon it, that it became in a manner inhabited by devotees, and from

Athos
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Athy.

thence received the name of the *Holy Mountain*; which name it ſtill retains, though many of thoſe conſecrated works are now decayed. According to the accounts of modern travellers, this mountain advances into the Archipelago, being joined to the continent by an iſthmus about half a league in breadth. It is about 30 miles in circumference, and two in perpendicular height. It may be tavelled over in about three days, and may be ſeen 90 miles off. There is a fine proſpect from the top; but, like all other high mountains, the cold on its ſummit is exceſſive. It abounds with many different kinds of plants and trees, particularly the pine and fir. In the valleys grows a plant called *elegia*, whoſe branches ſerve to make pens for writing. In ſhort, this mountain is ſaid to be adorned with variety of herbage and evergreens, a multitude of ſprings and ſtreams, and woods growing near the ſhore, ſo as to be one of the moſt agreeable places in the world.

It is now inhabited by Caloyers, a ſort of Greek monks, of the order of St Baſil, who never marry, though others of that church do. They abſtain from fleſh, and fare very hardly, their ordinary meal being olives pickled when they are ripe. They are about 6000 in all, and inhabit ſeveral parts of the mountain, on which are 24 large old monaſteries, ſurrounded with high walls for a defence againſt banditti. They are ſo reſpected, that the Turks themſelves will often ſend them alms. Theſe monks are not idle like others; but labour with the ax, ſpade, and ſickle, dreſſing themſelves like hermits. Formerly they had fine Greek manuſcripts; but are now become ſo illiterate, that they can ſcarce read or write.

Through this mountain, or rather through the iſthmus behind it, Xerxes king of Perſia is ſaid to have cut a paſſage for his fleet when about to invade Greece. In this work he ſpent three whole years, and employed in it all the forces on board the fleet. He is alſo ſaid, before the work was begun, to have written the following inſolent and ridiculous letter to the mountain: "Athos, thou proud and aſpiring mountain, that lifteſt up thy head to the very ſkies, I adviſe thee not to be ſo audacious as to put rocks and ſtones that cannot be cut in the way of my workmen. If thou makeſt that oppoſition, I will cut thee entirely down, and throw thee headlong into the ſea." The directors of this enterpriſe are ſaid to have been Bubaris the ſon of Megabyzus, and Artacheus the ſon of Arbeus, both Perſians; but as no traces of ſuch a great work remain, the truth of the whole relation has juſtly been called in queſtion.

ATHWART, in navigation, is ſynonimous with acroſs the line of the courſe.

Athwart the Fore-foot, is a phraſe that denotes the flight of a cannon-ball from one ſhip acroſs the courſe of another, to intercept the latter, and oblige her to ſhorten ſail, that the former may come near enough to examine her.

Athwart-Hauſe, expreſſes the ſituation of a ſhip, when ſhe is driven by wind or tide, or any other accident, acroſs the fore-part of another.

Athwart-Ships, reaching acroſs ſhips from one ſide to the other.

ATHY, a town of Ireland in the county of Kildare, not far from the borders of Queen's county. W. Long. 7. 0. N. Lat. 53. 0. It is ſituated on the river Barrow; is governed by a ſovereign, two bailiffs, and a recorder, and is, alternately with Naas, the aſſizes town.

Atibar
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Atlantides.

ATIBAR, the name by which the inhabitants of the kingdom of Gago in Africa call gold-duſt; from which word Europeans, and eſpecially the French, have compoſed the word *tibir*, which alſo ſignifies gold-duſt among thoſe who trade in that commodity.

ATIGNY, an ancient town of Champagne in France, where ſeveral of the kings of France had their reſidence. It is ſeated on the river Arſne, in E. Long. 4. 47. N. Lat. 49. 30.

ATKINS (Sir Robert), lord chief baron of the exchequer, was born in 1621, and educated at the univerſity of Oxford, from whence he removed to the inns of court, and became eminent in the law. He was made knight of the Bath, with many other perſons of the firſt diſtinction, at the coronation of King Charles II. In 1672, he was appointed one of the judges of Common Pleas; in which honourable ſtation he continued till 1679, when, foreſeeing the troubles that ſoon after enſued, he thought fit to reſign, and retire into the country. In 1689, he was made by King William lord chief baron of the exchequer; and about the ſame time executed the office of ſpeaker to the houſe of lords, which had been previouſly refuſed by the Marquis of Halifax. He diſtinguiſhed himſelf by an unſhaken zeal for the laws and liberties of his country. He wrote ſeveral pieces, which have been collected into one volume 8vo, under the title of *Parliamentary and Political Tracts*. The authors of the Biographia Britannica remark, that whoever inclines to be thoroughly informed of the true conſtitution of his country, of the grounds and reaſons of the revolution, and of the danger of ſuffering prerogative to joſtle law, cannot read a better or plainer book than thoſe tracts of Sir Robert Atkins. He died in 1709, aged 88.

ATKINS (Sir Robert), ſon of the preceding, was born in 1646, and was eminent for all the virtues that could adorn an Engliſh gentleman. He wrote The Ancient and Preſent State of Glouceſterſhire, in one large volume in folio; and died October 29, 1711.

ATKYNS (Richard), was deſcended from a good family, and was born at Tuffleigh in Glouceſterſhire, in the year 1615. He was educated at Oxford, from whence he removed to Lincoln's Inn, and afterwards diſtinguiſhed himſelf by his loyalty to King Charles I. for whom he raiſed a troop of horſe at his own expence. At the Reſtoration he was made one of the deputy lieutenants of Glouceſterſhire, and diſtinguiſhed himſelf by his attachment to the government. But at length being committed priſoner to the Marſhalſea in Southwark for debt, he died there on the 14th of September 1677. He wrote ſeveral pieces, particularly A Treatiſe on the Original and Growth of Printing.

ATLANTIC OCEAN, that bounded by Europe and Africa on the eaſt, and by America on the weſt.

ATLANTICA. See ATLANTIS.

ATLANTIDES, in aſtronomy, a denomination given to the Pleiades, or ſeven ſtars, ſometimes alſo called *Vergilliæ*. They are thus called, as being ſuppoſed

Atlantis

ſed by the poets to have been the daughters either of Atlas or his brother Heſperus, who were tranſlated into heaven.

ATLANTIS, ATALANTIS, or ATLANTICA, an iſland mentioned by Plato and ſome others of the ancients, concerning the real exiſtence of which many diſputes have been raiſed. Homer, Horace, and the other poets, make two Atlanticas, calling them *Heſperides* and *Elyſian Fields*, making them the habitations of the bleſſed. The moſt diſtinct account of this iſland we have in Plato's Timæus, of which Mr Chambers gives the following abridgment. "The Atlantis was a large iſland in the weſtern ocean, ſituated before or oppoſite to the ſtraits of Gades. Out of this iſland there was an eaſy paſſage into ſome others, which lay near a large continent exceeding in bigneſs all Europe and Aſia. Neptune ſettled in this iſland (from whoſe ſon Atlas its name was derived), and divided it among his ten ſons. To the youngeſt fell the extremity of the iſland, called *Gadir*, which in the language of the country ſignifies *fertile*, or *abundant in ſheep*. The deſcendants of Neptune reigned here from father to ſon for a great number of generations in the order of primogeniture, during the ſpace of 9000 years. They alſo poſſeſſed ſeveral other iſlands; and, paſſing into Europe and Africa, ſubdued all Lybia as far as Egypt, and all Europe to Aſia Minor. At length the iſland ſunk under water, and for a long time afterwards the ſea thereabouts was full of rocks and ſhelves."

Many of the moderns alſo are of opinion, that the exiſtence of the Atlantis is not to be looked upon as entirely fabulous. Some take it to have been America; and from thence, as well as from a paſſage in Seneca's Medea, and ſome other obſcure hints, they imagine that the new world was not unknown to the ancients. But allowing this to be the caſe, the abovementioned continent which was ſaid to lie beyond Atlantis would ſeem rather to have been the continent of America than Atlantis itſelf. The learned Rudbeck, profeſſor in the univerſity of Upſal, in a work intitled *Atlantica ſive Manheim*, endeavours to prove that Sweden and Norway are the Atlantis of the ancients; but this its ſituation will by no means allow us to believe. By Kircher it is ſuppoſed to have been an iſland extending from the Canaries quite to the Azores; that it was really ſwallowed up by the ocean as Plato aſſerts: and that theſe ſmall iſlands are the ſhattered remains of it which were left ſtanding.

ATLANTIS (New), is the name of a fictitious philoſophical commonwealth, of which a deſcription has been given by Lord Bacon.—The new Atlantis is ſuppoſed to be an iſland in the South Sea, to which the author was driven in a voyage from Peru to Japan. The compoſition is an ingenious fable, formed after the manner of the Utopia of Sir Thomas More, or Campanella's City of the Sun. Its chief deſign is to exhibit a model or deſcription of a college, inſtituted for the interpretation of nature and the production of great and marvellous works, for the benefit of men, under the name of *Solomon's Houſe*, or "the college of the ſix day's work." Thus much, at leaſt, is finiſhed; and with great beauty and magnificence. The author propoſed alſo a frame of laws, or of the beſt ſtate or mould of a commonwealth. But this part is not executed.

Atlas.

ATLAS, king of Mauritania, a great aſtronomer, contemporary with Moſes. From his taking obſervations of the ſtars from a mountain, the poets feigned him to have been turned into a mountain, and to ſuſtain the heavens on his ſhoulders. Being an excellent aſtronomer, and the firſt who taught the doctrine of the ſphere, they tell us that his daughters were turned into ſtars; ſeven of them forming the Pleiades, and other ſeven the Hyades.

ATLAS, a chain of mountains in Africa, lying between the 20th and 25th degree of north latitude, and ſuppoſed almoſt to divide the continent from eaſt to weſt. They are ſaid to have derived their name from Atlas king of Mauritania, who was a great aſtronomer. They are greatly celebrated by the ancients on account of their height, inſomuch that the abovementioned king, who is ſaid to have been tranſformed into a mountain, was feigned to bear up the heavens on his ſhoulders. We are aſſured, however, by Dr Shaw, that the part of this chain of mountains which fell under his obſervation could not ſtand in competition either with the Alps or Apennines. He tells us, that if we conceive a number of hills, uſually of the perpendicular height of 400, 500, or 600 yards, with an eaſy aſcent, and ſeveral groves of fruit or foreſt trees, riſing up in a ſucceſſion of ranges above one another; and that if to this proſpect we add now and then a rocky precipice, and on the ſummit of each imagine a miſerable mud-walled village; we ſhall then have a juſt idea of the mountains of Atlas.

According to M. Chenier*, this mountain is formed by an endleſs chain of lofty eminences, divided into different countries, inhabited by a multitude of tribes, whoſe ferocity permits no ſtranger to approach. "I have not been able (continues he) to obtain a ſufficient knowledge of theſe mountains to deſcribe them accurately: What Leo Africanus has ſaid of them is very vague; and his account is the leſs to be regarded at preſent, as it is now about three centuries ſince he wrote, and the face of the country has been in that time totally changed. Nothing perhaps would be more intereſting to the curioſity of the philoſopher, or conduce more to the improvement of our knowledge in natural hiſtory, than a journey over mount Atlas. The climate, though extremely cold in winter, is very healthy and pleaſant; the valleys are well cultivated, abound in fruits, and are diverſified by foreſts and plentiful ſprings, the ſtreams of which uniting at a little diſtance, form great rivers, and loſe themſelves in the ocean. According to the reports of the Moors, there are many quarries of marble, granite, and other valuable ſtone, in theſe mountains: It is probable there are alſo mines, but the inhabitants have no idea of theſe riches; they conſider their liberty, which their ſituation enables them to defend, as the moſt ineſtimable of all treaſures."

* *Hiſt. of Morocco*, l. 13.

ATLAS, in matters of literature, denotes a book of univerſal geography, containing maps of all the known parts of the world.

ATLAS, in commerce, a ſilk-ſattin, manufactured in the Eaſt-Indies. There are ſome plain, ſome ſtriped, and ſome flowered, the flowers of which are either gold or only ſilk. There are atlaſſes of all colours; but moſt of them falſe, eſpecially the red and the crimſon. The manufacture of them is admirable; the gold

and

Atmosphere.

and silk being worked together after such a manner as no workmen in Europe can imitate; yet they are very far from having that fine gloss and lustre which the French know how to give to their silk stuffs. In the Chinese manufactures of this sort, they gild paper on one side with leaf-gold; then cut it in long slips, and weave it into their silks; which makes them with very little cost, look very rich and fine. The same long slips are twisted or turned about silk threads, so artificially, as to look finer than gold thread, though it be of no great value.

ATMOSPHERE, a word generally used to signify the whole mass of fluid consisting of air, aqueous and other vapours, electric fluid, &c. surrounding the earth to a considerable height.

1 Atmosphere composed of two different fluids.

The composition of that part of our atmosphere properly called *air*, was till lately very much unknown. In former times it was supposed to be a simple, homogeneous, and elementary fluid. The experiments of Dr Priestly discovered, that the purest kind of air, which he called *dephlogisticated*, was in reality a compound, and might be artificially produced in various ways. His first conjectures concerning its component parts were, that it consisted of earth, nitrous acid, and phlogiston. Subsequent experiments rendered these conjectures dubious; and at last it was supposed that dephlogisticated air is a pure elementary substance, the vivifying principle to animals, and the acidifying principle throughout all nature. This dephlogisticated air, however, is but a small part of the composition of our atmosphere. According to the most accurate computations, the air we usually breathe is composed of only one-fourth of this dephlogisticated air, or perhaps less; the other three or four parts consisting of what Dr Priestley calls *phlogisticated*, and M. Lavoisier *mephitic air*. This by itself is absolutely noxious, and exceedingly poisonous to animals: though it seems only to be negatively so; for when mixed in a certain proportion with dephlogisticated air, it may be breathed with safety, which could not be if it contained any ingredient absolutely unfriendly to the human constitution. The other part, viz. the pure dephlogisticated air, seems to stand much in the same relation to plants that phlogisticated air does to animals; that is, it would prove poisonous, and destroy them if they were to depend upon it entirely for their subsistence; but as they derive their nourishment partly from the air and partly from the soil, it thence happens, that the plants which are set to grow in dephlogisticated air do not die instantly, as animals do in the phlogisticated kind, but remain for some time weak and sickly.

2 Phlogisticated air poisonous to animals, and dephlogisticated air to vegetables.

3 A great quantity of electric fluid contained in the atmosphere

The other component parts of our atmosphere are so various, and of such heterogeneous natures, that they do not admit of any kind of definition or analysis, one only excepted, namely, the *electric fluid*. This we know pervades the whole, but appears to be much more copious in the upper than in the lower atmospherical regions. See ELECTRICITY. To measure the absolute quantity of this fluid, either in the atmosphere or any other substance, is impossible. All that we can know on this subject is, that the electric fluid pervades the atmosphere; that it appears to be more abundant in the superior than the inferior regions; that it seems to be the immediate bond of connection between the atmosphere and the water which is suspended in it; and that by its various operations, the phenomena of hail, rain, snow, lightning, and various other kinds of meteors, are occasioned. See RAIN, HAIL, SNOW, &c.

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4 Calculations of the height of the atmosphere.

Various attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered, by means of the Torricellian tube, that air is a gravitating substance. Thus it also became known, that a column of air, whose base is a square inch, and the height that of the whole atmosphere, weighs 15 pounds; and that the weight of air is to that of mercury as 1 to 10,800: whence it follows, that if the weight of the atmosphere be sufficient to raise a column of mercury to the height of 30 inches, the height of the aerial column must be 10,800 times as much, and consequently a little more than five miles high.

It was not, however, at any time supposed, that this calculation could be just: for as the air is an elastic fluid, the upper parts must expand to an immense bulk, and thus render the calculation above related exceedingly erroneous. By experiments made in different countries, it has been found, that the spaces which any portion of air takes up, are reciprocally proportional to the weights with which it is compressed. Allowances were therefore to be made in calculating the height of the atmosphere. If we suppose the height of the whole divided into innumerable equal parts, the density of each of which is as its quantity; and the weight of the whole incumbent atmosphere being also as its quantity; it is evident, that the weight of the incumbent air is every where as the quantity contained in the subjacent part; which makes a difference between the weights of each two contiguous parts of air. By a theorem in geometry, where the differences of magnitudes are geometrically proportional to the magnitudes themselves, these magnitudes are in continual arithmetical proportion; therefore, if, according to the supposition, the altitude of the air, by the addition of new parts into which it is divided, do continually increase in arithmetical proportion, its density will be diminished, or (which is the same thing, its gravity decreased) in continual geometrical proportion.

It is now easy, from such a series, by making two or three barometrical observations, and determining the density of the atmosphere at two or three different stations, to determine its absolute height, or its rarity at any assignable height. Calculations accordingly were made upon this plan; but it having been found that the barometrical observations by no means corresponded with the density which, by other experiments, the air ought to have had, it was suspected that the upper part of the atmospherical regions were not subject to the same laws with the lower ones. Philosophers therefore had recourse to another method for determining the altitude of the atmosphere, viz. by a calculation of the height from which the light of the sun is refracted, so as to become visible to us before he himself is seen in the heavens. By this method it was determined, that at the height of 45 miles the atmosphere had no power of refraction; and consequently beyond that distance was either a mere vacuum, or the next thing to it, and not to be regarded.

5 Height of it determined from the beginning and end of twilight.

This theory soon became very generally received and the height of the atmosphere was spoken of as familiarly

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miliarly as the height of a mountain, and reckoned to be as well aſcertained, if not more ſo, than the heights of moſt mountains are. Very great objections, however, which have never yet been removed, ariſe from the appearances of ſome *meteors*, like large globes of fire, not unfrequently to be ſeen at vaſt heights above the earth (ſee METEOR). A very remarkable one of this kind was obſerved by Dr Halley in the month of March 1719, whoſe altitude he computed to have been between 69 and 73½ Engliſh miles; its diameter 2800 yards, or upwards of a mile and an half; and its velocity about 350 miles in a minute. Others, apparently of the ſame kind, but whoſe altitude and velocity were ſtill greater, have been obſerved: particularly that very remarkable one, Auguſt 18th 1781, whoſe diſtance from the earth could not be leſs than 90 miles, and its diameter not leſs than the former; at the ſame time that its velocity was certainly not leſs than 1000 miles in a minute. Fire-balls, in appearance ſimilar to theſe, though vaſtly inferior in ſize, have been ſometimes obſerved at the ſurface of the earth. Of this kind Dr Prieſtley mentions one ſeen on board the Montague, 4th November 1749, which appeared as big as a large millſtone, and broke with a violent exploſion.

6 Objection from the appearance of meteors.

From analogical reaſoning, it ſeems very probable, that the meteors which appear at ſuch great heights in the air are not eſſentially different from thoſe which, like the fire-ball juſt mentioned, are met with on the ſurface of the earth. The perplexing circumſtances with regard to the former are, that at the great heights abovementioned, the atmoſphere ought not to have any denſity ſufficient to ſupport flame, or to propagate ſound; yet theſe meteors are commonly ſucceeded by one or more exploſions, nay are ſometimes ſaid to be accompanied with a hiſſing noiſe as they paſs over our heads. The meteor of 1719 was not only very bright, inſomuch that for a ſhort ſpace it turned night into day, but was attended with an exploſion heard over all the iſland of Britain, occaſioning a violent concuſſion in the atmoſphere, and ſeeming to ſhake the earth itſelf. That of 1783 alſo, though much higher than the former, was ſucceeded by exploſions; and, according to the teſtimony of ſeveral people, a hiſſing noiſe was heard as it paſſed. Dr Halley acknowledged that he was unable to reconcile theſe circumſtances with the received theory of the height of the atmoſphere; as, in the regions in which this meteor moved, the air ought to have been 300,000 times more rare than what we breathe, and the next thing to a perfect vacuum.

In the meteor of 1783, the difficulty is ſtill greater, as it appears to have been 20 miles farther up in the air. Dr Halley offers a conjecture, indeed, that the vaſt magnitude of ſuch bodies might compenſate for the thinneſs of the medium in which they moved. Whether or not this was the caſe, cannot indeed be aſcertained, as we have ſo few data to go upon; but the greateſt difficulty is to account for the brightneſs of the light. Appearances of this kind are indeed with great probability attributed to electricity, but the difficulty is not thus removed. Though the electrical fire pervades with great eaſe the vacuum of a common air-pump, yet it does not in that caſe appear in bright well defined ſparks, as in the open air, but rather in long ſtreams reſembling the aurora borealis. From ſome late experiments indeed, Mr Morgan concludes, that the electrical fluid cannot penetrate a perfect vacuum*. If this is the caſe, it ſhows that the regions we ſpeak of are not ſuch a perfect vacuum as can be artificially made; but whether it is or not, the extreme brightneſs of the light ſhows that a fluid was preſent in thoſe regions, capable of confining and condenſing the electric matter as much as the air does at the ſurface of the ground; for the brightneſs of theſe meteors, conſidering their diſtance, cannot be ſuppoſed inferior to that of the brighteſt flaſhes of lightning.

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* See *Electricity*-Index.

7 Denſity of the air does not always keep pace with its gravity.

This being the caſe, it appears reaſonable to conclude that what is called the *denſity* of the air does not altogether keep pace with its gravity. The latter indeed muſt in a great meaſure be affected by the vapours, but above all by the quantity of the baſis of fixed or dephlogiſticated air contained in it: for Mr Kirwan has diſcovered that the baſis of fixed air, when deprived of its elaſtic principle, is not greatly inferior to gold in ſpecific gravity; and we cannot ſuppoſe that of dephlogiſticated air to be much leſs. It is poſſible, therefore, that pure air, could it be deprived of all the water it contains, might have very little gravity; and as there is great reaſon to believe that the baſis of dephlogiſticated air is only one of the conſtituent parts of water †, we ſee an evident reaſon why the air ought to become lighter, and likewiſe leſs fit for reſpiration, the higher up we go, though there is a poſſibility that its denſity, or power of ſupporting flame, may continue unaltered.

† See *Dephlogiſticated air*, and *Water*.

There are not yet, however, a ſufficient number of facts to enable us to determine this queſtion; though ſuch as have been diſcovered ſeem rather to favour the above conjecture. Dr Boerhaave was of opinion that the gravity of the air depended entirely on the water it contained; and, by means of alkaline ſalts, he was enabled to extract as much water from a quantity of air as was very nearly equivalent to its weight. By the calcination of metals we may extract as much of the baſis of dephlogiſticated air from a quantity of atmoſpherical air as is equivalent to the weight of air loſt. Were it poſſible, therefore, to extract the whole of this, as well as all other vapours, and to preſerve only the elaſtic principle, it is highly probable that its gravity would entirely ceaſe. It has been found by thoſe who have aſcended with aeroſtatic machines, or to the tops of high mountains, that the deplogiſticated air is found to be contained in ſmaller quantities in the atmoſphere of theſe elevated regions than on the lower grounds. It is alſo found, that in ſuch ſituations the air is much drier, and parts with water with much more difficulty, than on the ordinary ſurface. Salt of tartar, for inſtance, which at the foot of a mountain will very ſoon run into a liquid, remains for a long time expoſed to the air on the top of it, without ſhowing the leaſt tendency to deliqueſce. Nevertheleſs, it hath never been obſerved that fires did not burn as intenſely on the tops of the higheſt monntains as on the plains. The matter indeed was put to the trial in the great eruption of Veſuvius in 1779, where, though the lava ſpouted up to the height of three miles above the level of the ſea, the uppermoſt parts all the while were to appearance as much inflamed as the loweſt.

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The high degree of electricity, always exiſting in the upper regions of the atmoſphere, muſt of neceſſity have a very conſiderable influence on the gravity of any heterogeneous particles floating in it. When we conſider the effects of the electric fluid upon light bodies at the ſurface of the earth, it will readily be admitted, that in thoſe regions where this fluid is very abundant, the gravity of the atmoſphere may be much diminiſhed without affecting its denſity. We know that it is the nature of any electrified ſubſtance to attract light bodies; and that, by proper management, they may even be ſuſpended in the air, without either moving up or down for a conſiderable time. If this is the caſe with light terreſtrial bodies it cannot be thought very improbable that the aerial particles themſelves, *i. e.* thoſe which we call the baſis of dephlogiſticated air, and of aqueous or other vapour diffuſed among them, ſhould be thus affected in the regions where electricity is ſo abundant. From this cauſe, therefore, alſo the gravity of the atmoſphere may be affected without any alteration at all being made in its denſity; and hence may ariſe anomalies in the barometer hitherto not taken notice of.

8 Gravity of the upper regions of the atmoſphere perhaps diminiſhed by electricity.

9 Abſolute height of the atmoſphere undetermined

It appears, therefore, that the abſolute height of the atmoſphere is not yet determined. The beginning and ending of twilight indeed ſhow, that the height at which the atmoſphere begins to refract the ſun's light is about 44 or 45 Engliſh miles. But this may not improbably be only the height to which the aqueous vapours are carried: for it cannot be thought any unreaſonable ſuppoſition, that light is refracted only by means of the aqueous vapour contained in the atmoſphere; and that where this ceaſes, it is ſtill capable of ſupporting the *electric* fire at leaſt, as bright and ſtrong as at the ſurface. That it does extend much higher, is evident from the meteors already mentioned: for all theſe are undoubtedly carried along with the atmoſphere; otherwiſe that of 1783, which was ſeen for about a minute, muſt have been left 1000 miles to the weſtward, by the earth flying out below it in its annual courſe round the ſun.

10 Of the preſſure of the atmoſphere

It has already been mentioned, that the preſſure of the atmoſphere, when in its mean ſtate, is equivalent to a weight of 15 pounds on every ſquare inch. Hence Dr Cotes computed, that the preſſure of the whole ambient fluid upon the earth's ſurface is equivalent to that of a globe of lead 60 miles in diameter. Hence alſo it appears, that the preſſure upon a human body muſt be very conſiderable; for as every ſquare inch of ſurface ſuſtains a preſſure of 15 pounds, every ſquare foot, as containing 144 inches, muſt ſuſtain a preſſure of 2160; and if we ſuppoſe a man's body to contain 15 ſquare feet of ſurface, which is pretty near the truth, he muſt ſuſtain a weight of 32,400 pounds, or 16 tun, for his ordinary load. By this enormous preſſure we ſhould undoubtedly be cruſhed in a moment, were not all parts of our bodies filled either with air or ſome other elaſtic fluid, the ſpring of which is juſt ſufficient to counterbalance the weight of the atmoſphere. But whatever this fluid may be, we are ſure that it is juſt able to counteract the atmoſpherical gravity and no more; for if any conſiderable preſſure be ſuperadded to that of the air, as by going into deep water, or the like, it is always ſeverely felt, let it be ever ſo equable. If the preſſure of the atmoſphere is taken off from any part of the human body, the hand, for inſtance, when put in an open receiver from whence the air is afterwards extracted, the weight of the atmoſphere then diſcovers itſelf, and we imagine the hand ſtrongly ſucked down into the glaſs. See PNEUMATICS.

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11 Variation of the preſſure, and its effects.

In countries at ſome diſtance from the equator, the preſſure of the atmoſphere varies conſiderably, and thus produces conſiderable changes on many terreſtrial bodies. On the human body the quantity of preſſure ſometimes varies near a whole tun; and when it is thus ſo much diminiſhed, moſt people find ſomething of a liſtleſſneſs and inactivity about them. It is ſurpriſing, however, that the ſpring of the internal fluid, already mentioned, which acts as a counterpoiſe to the atmoſpherical gravity, ſhould in all caſes ſeem to keep pace with it when the preſſure is naturally diminiſhed, and even when it is artificially augmented, though not when the preſſure is artificially diminiſhed. Thus in that kind of weather when the preſſure of the air is leaſt, we never perceive our veins to ſwell, or are ſenſible of any inward expanſion in our bodies. On the contrary, the circulation is languid, and we ſeem rather to be oppreſſed by a weight. Even in going up to the tops of mountains, where the preſſure in the atmoſphere is diminiſhed more than three times what it uſually is on the plain, no ſuch appearances are obſerved. Some travellers indeed have affirmed, that, on the tops of very high mountains, the air is ſo light as to occaſion a great difficulty of reſpiration, and even violent retching and vomiting of blood. It does not appear, however, that theſe aſſertions are well founded. Mr Brydone found no inconvenience of this kind on the top of mount Ætna; nor is any ſuch thing mentioned by Mr Houel, who alſo aſcended this mountain. Sir William Hamilton indeed ſays, that he did feel a difficulty of reſpiration, independent of any ſulphureous ſtream. But, on the top of a volcano, the reſpiration may be affected by ſo many different cauſes, that it is perhaps impoſſible to aſſign the true one. The French mathematicians, when on the top of a very high peak of the Andes, did not make any complaint of this kind, though they lived there for ſome time. On the contrary, they found the wind ſo extremely violent, that they were ſcarce able to withſtand its force; which ſeems an argument for at leaſt equal *denſity* of the atmoſphere in the ſuperior as in the inferior regions. Dr Heberden, who aſcended to the top of Teneriffe, a higher mountain than Ætna, makes no mention of any difficulty of reſpiration. M. Sauſſure, however, in his journey to the top of Mount Blanc, the higheſt of the Alps, felt very great uneaſineſs in the way. His reſpiration was not only extremely difficult, but his pulſe became quick, and he was ſeized with all the ſymptoms of a fever. His ſtrength was alſo exhauſted to ſuch a degree, that he ſeemed to require four times as long a ſpace to perform ſome experiments on the top of the mountain as he would have done at the foot of it. It muſt be obſerved, however, that theſe ſymptoms did not begin to appear till he had aſcended two miles and a half perpendicular above the level of the ſea. The mountain is only about a quarter of a mile higher; and in this ſhort ſpace he was reduced to the ſituation juſt mentioned. But it is improbable that ſo ſmall a difference, even at the end

12 Of difficulty of reſpiration on the tops of mountains.

13 Mr Sauſſure's ſymptoms on the top of Mount Blanc accounted for

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of his journey, ſhould have produced ſuch violent effects, had not ſome other cauſe concurred. A cauſe of this kind he himſelf mentions, viz. that the atmoſphere at the top of the mountain was ſo much impregnated with fixed air, that lime-water, expoſed to it, quickly became covered with a pellicle occaſioned by the abſorption of that fluid. Now it is known, that fixed air is extremely pernicious to animals, and would bring on ſymptoms ſimilar to thoſe abovementioned. There is no reaſon, therefore, to have recourſe to the rarity of the atmoſphere for ſolving a phenomenon which may more naturally be accounted for otherwiſe.

When the preſſure of the atmoſphere is augmented, by deſcending, in the diving-bell, to conſiderable depths in the ſea, it does not appear that any inconvenience follows from its increaſe. Thoſe who ſit in the diving-bell are not ſenſible of any preſſure as long as they remain in the air, though they feel it very ſenſibly in going into the water: yet it is certain, that the preſſure in both caſes is the ſame; for the whole preſſure of the atmoſphere, as well as of the water, is ſuſtained by the air in the diving-bell, and conſequently communicated to thoſe who ſit in it.

But though artificial compreſſion of the air, as well as natural rarefaction, can thus be borne, it is otherwiſe with artificial rarefaction. Animals in an air-pump ſhow uneaſineſs from the very firſt, and cannot live for any time in an atmoſphere rarefied artificially even as much as it appeared to be from the barometer on the top of Mount Blanc.

14 Variation of the atmoſpherical preſſure accounted for.

It is not eaſy to aſſign the true reaſon of the variations of gravity in the atmoſphere. Certain it is, however, that they take place only in a very ſmall degree within the tropics; and ſeem there to depend on the heat of the ſun, as the barometer conſtantly ſinks near half an inch every day, and riſes again to its former ſtation in the night-time. In the temperate zones the barometer ranges from 28 to near 31 inches, by its various altitudes ſhowing the changes that are about to take place in the weather. If we could know, therefore, the latent cauſes by which the weather is influenced, we ſhould likewiſe certainly know thoſe by which the gravity of the atmoſphere is affected. Theſe are particularly explained under the articles RAIN, HAIL, SNOW, WINDS, &c. but in general they may be reduced to two, viz. an emiſſion of latent heat from the vapour contained in the atmoſphere, or of electric fluid from the ſame, or from the earth. To one or both of theſe cauſes, therefore, may we aſcribe the variations of the gravity of the atmoſphere: and we ſee that they both tend to produce the ſame effect with the ſolar heat in the tropical climates, viz. to rarefy the air, by mixing with it or ſetting looſe a non-gravitating fluid, which did not act in ſuch large proportion in any particular place before. No doubt, the action of the latent heat and electric fluid is the ſame in the torrid as in the temperate zones: but in the torrid zone the ſolar heat and exceſſive evaporation counteract them; ſo that whatever quantities may be diſcharged by the exceſſive deluges of rain, &c. which fall in thoſe countries, they are inſtantly abſorbed by the abundant fluid, and are quickly ready to be diſcharged again; while, in the temperate zones, the air becomes ſenſibly lighter, as well as warmer, by them for ſome time before they can be abſorbed again.

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15 Variation of the heat and cold of the atmoſphere.

The variations of heat and cold to which the atmoſphere is ſubject, have been the ſubject of much ſpeculation. In general they ſeem to depend entirely upon the light of the ſun reflected into the atmoſphere from the earth; and where this reflection is deficient, even though the light ſhould be preſent ever ſo much, the moſt violent degrees of cold are found to take place. Hence, on the tops of mountains, the cold is generally exceſſive, though by reaſon of the clearneſs of the atmoſphere the light of the ſun falls upon them in greater quantity than it can do on an equal ſpace on the plain. In long winding paſſages alſo, ſuch as the caverns of Ætna and Veſuvius, where the air has room to circulate freely, without any acceſs of the ſun, the cold is ſcarce tolerable; whence the uſe of theſe for cooling liquors, preſerving meat, &c.

16 Lambert and De Luc's reaſons for the cold on the tops of mountains.

The coldneſs of the atmoſphere on the tops of mountains has been aſcribed by M. Lambert and De Luc, to the igneous fluid, or elementary fire, being more rare in thoſe elevated ſituations than on the plains. M. Lambert is of opinion that it is rarefied above by the action of the air, and that below it is condenſed by its own proper weight. He conſiders fire as a fluid in motion, the parts of which are ſeparable, and which is rarefied when its velocity is accelerated. He does not decide with regard to the identity of fire and light, though he ſeems inclined to believe it. M. de Luc compares elementary fire to a continuous fluid, whoſe parts are condenſed by being mutually compreſſed. He denies that fire and light are the ſame; and maintains that the latter is incapable, by itſelf, of ſetting fire to bodies, though it does ſo by putting in motion the igneous fluid they contain; and that it acts with more force near the earth than at a diſtance from its ſurface, by reaſon of this fluid, which he calls an *heavy* and *elaſtic* one, being more condenſed there than at a greater height.

17 Mr Sauſſure's account.

Mr Sauſſure, in treating of this ſubject in his account of the Alps, does not conſider fire as a fluid ſo free and detached as to be able either to aſcend with rapidity by its ſpecific levity, or to condenſe itſelf ſenſibly by its proper weight. He ſuppoſes it to be united to bodies by ſo ſtrict an affinity, that all its motions are determined, or at leaſt powerfully modified, by that affinity. As ſoon therefore as fire, diſengaged by combuſtion or by any other cauſe, endeavours to diffuſe itſelf, all the bodies that come within the ſphere of its activity endeavour to attract it; and they abſorb ſuch quantities of it as are in the direct ratio of their affinities with it, or in the inverſe ratio of what is neceſſary for their equilibrium with the ſurrounding bodies. Now it does not appear that in this diſtribution the ſituation of places, with regard to the horizon, has any other influence than what they receive from the different currents produced by the dilatation of the air, and by the levity which that dilatation produces. The aſcent of flame, ſmoke, &c. or of air heated in any way, perſuaded the ancients that fire is poſſeſſed of abſolute levity, by which it had a tendency to mount upwards. "But theſe effects (ſays he) are owing either to the levity of the fluid which conſtitutes flame, or to that of air dilated by heat; and not to the levity of the igne-

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igneous fluid. I am, however, ſufficiently convinced, that this fluid is incomparably lighter than air, though I do not believe that it poſſeſſes the power of aſcending in our atmoſphere by virtue of its levity alone.

18 Mr Bouguer's reaſons for the cold on the top of the Andes.

"The celebrated Bouguer has demonſtrated, by principles the moſt ſimple, and moſt univerſally adopted, that it is not neceſſary, in order to account for the diminution of heat on mountains, to have recourſe to hypotheſes that are at beſt doubtful. The following is his explanation of what was felt on the mountains of Peru.

"It was proper, in order to explain this ſubject, to inſiſt on the ſhort duration of the ſun's rays, which cannot ſtrike the different ſides of mountains but for a few hours, and even this not always. A horizontal plain, when the ſun is clear, is expoſed at mid-day to the perpendicular and undiminiſhed action of theſe rays, while they fall but obliquely on a plain not much inclined, or on the ſides of a high pile of ſteep rocks. But let us conceive for a moment an inſulated point, half the height of the atmoſphere, at a diſtance from all mountains, as well as from the clouds which float in the air. The more a medium is tranſparent, the leſs heat it ought to receive by the immediate action of the ſun. The free paſſage which a very tranſparent body allows to the rays of light, ſhows that its ſmall particles are hardly touched by them. Indeed what impreſſion could they make on it when they paſs through almoſt without obſtruction? Light, when it conſiſts of parallel rays, does not by paſſing through a foot of free atmoſpheric air, near the earth, loſe an hundred thouſandth part of its force. From this we may judge how few rays are weakened, or can act on this fluid, in their paſſage through a ſtratum of the diameter not of an inch or a line, but of a particle. Yet the ſubtilty and tranſparency are ſtill greater at great heights, as was obvious on the Cordilleras, when we looked at diſtant objects. Laſtly, the groſſer air is heated below by the contact or neighbourhood of bodies of greater denſity than itſelf, which it ſurrounds, and on which it reſts; and the heat may be communicated by little and little to a certain diſtance. The inferior parts of the atmoſphere by this means contract daily a very conſiderable degree of heat, and may receive it in proportion to its denſity or bulk. But it is evident, that the ſame thing cannot happen at the diſtance of a league and an half or two leagues above the ſurface of the earth, although the light there may be ſomething more active. The air and the wind therefore muſt at this height be extremely cold, and colder in proportion to the elevation.

"Beſides, the heat neceſſary to life is not merely that which we receive every inſtant from the ſun. The momentary degree of this heat correſponds to a very ſmall part of that which all the bodies around us have imbibed, and by which ours is chiefly regulated. The action of the ſun only ſerves to maintain nearly in the ſame ſtate the ſum of the total heat, by repairing thro' the day the loſs it ſuſtains through the night, and at all times. If the addition be greater than the loſs, the total heat will increaſe, as it happens in ſummer, and it will continue to accumulate in a certain degree; but for the reaſons already given, this accumulation cannot be very great on the top of a mountain, where the ſummit which riſes high, is never of great bulk. The loweſt ſtate of the thermometer in every place is always in proportion to the heat acquired by the ſoil; and that heat being very ſmall on the top of a mountain, the quantity added to it by the ſun during the day muſt be comparatively greater; and the accumulated heat will be more in a condition to receive increaſe in proportion to its diſtance from the degree which it cannot paſs. Atmoſphere.

"Another particular obſervable on all the high places of the Cordilleras, and which depends on the ſame cauſe, is, that when we leave the ſhade, and expoſe ourſelves to the ſunſhine, we feel a much greater difference than we do here in our fine days when the weather is temperate. Every thing contributes at Quito to make the ſun exceedingly powerful: a ſingle ſtep from an expoſed place to the ſhade gives the ſenſation of cold: this would not be the caſe if the quantity of heat acquired by the ſoil were more conſiderable. We now alſo ſee why the ſame thermometer, put firſt into the ſhade and then in the ſun, does not undergo the ſame changes at all times and in all places. In the morning, upon Pinchincha, this inſtrument is generally a few degrees below the freezing point, which may be reckoned the natural temperature of the place; but when during the day we expoſe it to the ſun, it is eaſy to imagine that the effect muſt be great, and much more than double in whatever way it is meaſured."

This theory is adopted by M. Sauſſure, who adds the following fact to prove that the action of the ſun's rays, conſidered abſtractedly, and independent of any extrinſic ſource of cold, is as great on mountains as on plains; viz. that the power of burning lenſes and mirrors is the ſame at all heights. To aſcertain this fact, our author procured a burning-glaſs ſo weak that at Geneva it would juſt ſet fire to tinder. This he carried with ſome of the ſame tinder, to the top of the mountain Saleve (a height of 3000 feet); where it not only produced the ſame effect, but apparently with greater facility than on the plain. Being perſuaded then, that the principal ſource of cold on the tops of high mountains is their being perpetually ſurrounded with an atmoſphere which cannot be much heated either by the rays of the ſun on account of its tranſparency, or by the reflection of them from the earth by reaſon of its diſtance, he wiſhed to know, whether the direct ſolar rays on the top of a high mountain had the ſame power as on the plain, while the body on which they acted was placed in ſuch a manner as to be unaffected by the ſurrounding air. For this purpoſe he inſtituted a ſet of experiments, from which he drew the following concluſions, viz. that a difference of 777 toiſes in height, diminiſhes the heat which the rays of the ſun are able to communicate to a body expoſed to the external air, 14° of the thermometer; that it diminiſhes the heat of a body partially expoſed, only 6°; and that it augments by 1° the heat of a third body completely defended from the air.

19 Burning glaſſes equally powerful on the tops of mountains as on plains.

Hence it appears that the atmoſphere, though ſo eſſentially neceſſary to the ſupport of fire, is ſome how or other the greateſt antagoniſt of heat, and moſt effectually counteracts the operation of the ſolar rays in producing it. This power it ſeems to exert at all diſtances, at the ſurface as well as in the higher regions. From ſome experiments made by M. Pictet, it appears, that

20 Atmoſphere every where counteracts the heat of the ſun.

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that even in places expoſed to the rays of the ſun, the heat, at five feet diſtance from the ground, is greater only by one or two degrees than at 50 feet above the ſurface, though the ground was at that time 15 or 20° warmer than the air immediately in contact with it. Inconſiderable as this difference is, however, it does not hold as we go higher up: for if it did, the cold on the top of the mountain of Saleve, which is 3000 feet above the level of the lake of Geneva, would be 60° greater than at the foot it; whereas in reality it is only 10°. In the night time the caſe is reverſed; for the ſtratum of air, at five feet from the ground, was found by Mr Pictet to be colder than that at 50. Beſides this, different ſtrata of the atmoſphere are found to poſſeſs very different and variable degrees of cold, without any regard to their ſituation high up or low down. In the year 1780, Dr Wilſon of Glaſgow found a very remarkable cold exiſting cloſe to the ſurface of the ground; ſo that the thermometer, when laid on the ſurface of the ſnow, ſunk many degrees lower than one ſuſpended 24 feet above it. It has been likewiſe obſerved, that in clear weather, though the ſurface of the earth be then moſt liable to be heated by the ſun, yet after that is ſet, and during the night, the air is coldeſt near the ground, and particularly in the valleys. Experiments on this ſubject were made for a whole year by Mr James Sex, who has given an account of them in the 78th volume of the Philoſophical Tranſactions. He ſuſpended thermometers (conſtructed in ſuch a manner as to ſhow the true maximum and minimum of heat that might take place in the obſerver's abſence) in a ſhady northern aſpect, and at different heights in the open air. One of theſe was placed at the height of 9 feet, and the other at that of 220 from the ground; and the obſervations were continued, with only a few days omiſſion, from July 1784 to July 1785. The greateſt variations of heat were in the months of October and June; in the former the thermometers generally differed moſt in the night, and in the latter moſtly in the day. From the 25th to the 28th of October, the heat below, in the night time, exceeded in a ſmall degree the heat above; at which time there was frequent rain mingled with hail. From the 11th to the 14th, and alſo on the 31ſt, there was no variation at all; during which time likewiſe the weather was rainy: all the reſt of the month proving clear, the air below was found colder than that above, ſometimes by nine or ten degrees. In the month of June, the greateſt variations took place from the 11th to the 15th, and from the 25th to the 30th; and at both theſe times there appeared to be two currents of wind, the upper from the ſouth-weſt and the lower from the north-eaſt. Sometimes theſe were rendered viſible by clouds, in different ſtrata, moving in different directions, and ſometimes by clouds moving in a contrary direction to a very ſenſible current of air below. On cloudy nights the loweſt thermometer ſometimes ſhowed the heat to be a degree or two greater than the upper one; but in the day time the heat below conſtantly exceeded that above more than in the month of October.

21 Is colder very near the ſurface of the ground than at ſome diſtance.

22 Mr Sex's experiments on this ſubject.

To determine whether the nocturnal refrigeration was augmented by a nearer approach to the earth, two thermometers were placed in the midſt of an open meadow, on the bank of the river near Canterbury. One was placed on the ground, and the other only ſix feet above it. The thermometer, at ſix feet diſtance from the ground, agreed nearly with the former at nine feet; but the nocturnal variations were found to correſpond entirely with the clearneſs or the cloudineſs of the ſky: and though they did not always happen in proportion to their reſpective altitudes, yet when the thermometers differed in any reſpect, that on the ground always indicated the greateſt degree of cold.

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The difference betwixt theſe two thermometers, at the ſmall diſtance of ſix feet from each other, being found no leſs than three degrees and an half, the number of thermometers in the meadow was augmented to four. One was ſunk in the ground, another placed juſt upon it, and the third ſuſpended at three feet above it. Three others were placed on a riſing ground where the land was level with the cathedral tower, and about a mile diſtant from it. One of theſe was likewiſe ſunk in the ground, another placed juſt upon it, and a third ſuſpended ſix feet above it. With theſe ſeven thermometers, and the two firſt mentioned, which were placed in the city, he continued his obſervations for 20 days; but as the weather happened to be cloudy during the whole of that ſpace, excepting for ſeven or eight days, no conſiderable variation happened excepting on theſe days. The reſult of the experiments was, that the cold was generally greater in the valley than on the hill; but the variations between the thermometers on the ground and thoſe ſix feet above them, were often as great on the hill as in the valley.

Thus it was perceived that a difference of temperature took place at the diſtance of only three feet from the ground; but the length of the thermometers hitherto made uſe of rendered it impoſſible to make any experiment at a ſmaller diſtance. Two new ones, therefore, were formed by bending down the large tube, the body or bulb of the thermometer, to an horizontal poſition, while the ſtem remained in a vertical one; by which method the temperature might be obſerved to the diſtance of a ſingle inch. Sometimes, in clear weather, theſe two horizontal thermometers were placed in the open air, one within an inch of the ground, and the other nine inches above it. When the variation among the other thermometers was conſiderable, a difference was likewiſe perceived between theſe; the lower one ſometimes indicating more than two degrees leſs heat than the upper one, though placed ſo near each other.

23 His concluſions from theſe experiments.

From theſe experiments Mr Sex concludes, that a greater diminution of heat frequently takes place near the earth in the night-time than at any altitude in the atmoſphere within the limits of his inquiry, that is, 220 feet from the ground; and at ſuch times the greateſt degrees of cold are always met with neareſt the ſurface of the earth.

This is a conſtant and regular operation of nature, under certain circumſtances and diſpoſitions of the atmoſphere, and takes place at all ſeaſons of the year; and this difference never happens in any conſiderable degree but when the air is ſtill, and the ſky perfectly unclouded. The moiſteſt vapour, as dews and fogs, did not at all impede, but rather promote, the refrigeration. In very ſevere froſts, when the air frequently depoſites a quantity of frozen vapour, it is commonly

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found greateſt; but the exceſs of heat which in the day-time was found at the lower ſtation in ſummer, diminiſhed in winter almoſt to nothing.

24 Mr Darwin's experiments on cold produced by the rarefaction of air.

It has been obſerved, that a thermometer, included in a receiver, always ſinks when the air begins to be rarefied. This has been thought to ariſe, not from any degree of cold thus produced, but from the ſudden expanſion of the bulb of the thermometer in conſequence of the removal of the atmoſpherical preſſure: But from ſome late experiments related, Phil. Tranſ. vol. 78. by Mr Darwin, it appears that the atmoſphere always becomes warm by compreſſion, and cold by dilatation from a compreſſed ſtate. Theſe experiments were,

1. The blaſt from an air-gun was repeatedly thrown upon the bulb of a thermometer, and it uniformly ſunk it about two degrees. In making this experiment the thermometer was firmly fixed againſt a wall, and the air-gun, after being charged, was left for an hour in its vicinity, that it might previouſly loſe the heat it had acquired in the act of charging: the air was then diſcharged in a continued ſtream on the bulb of the thermometer, with the effect already mentioned.

2. A thermometer was fixed in a wooden tube, and ſo applied to the receiver of an air-gun, that, on diſcharging the air by means of a ſcrew preſſing on the valve of the receiver, a continued ſtream of air, at the very time of its expanſion, paſſed over the bulb of the thermometer. This experiment was four times repeated, and the thermometer uniformly ſunk from five to ſeven degrees. During the time of condenſation there was a great difference in the heat, as perceived by the hand, at the two ends of the condenſing ſyringe: that next the air-globe was almoſt painful to the touch; and the globe itſelf became hotter than could have been expected from its contact with the ſyringe. "Add to this (ſays Mr Darwin), that in exploding an air-gun the ſtream of air always becomes viſible, which is owing to the cold then produced precipitating the vapour it contained; and if this ſtream of air had been previouſly more condenſed, or in greater quantity, ſo as not inſtantly to acquire heat from the common atmoſphere in its vicinity, it would probably have fallen in ſnow."

3. A thermometer was placed in the receiver of an air-pump, and the air being haſtily exhauſted, it ſunk two or three degrees; but after ſome minutes regained its former ſtation. The experiment was repeated with a thermometer open at the top, ſo that the bulb could not be affected by any diminution of the external preſſure; but the reſult was the ſame. Both during exhauſtion and readmiſſion of the air into the receiver, a ſteam was regularly obſerved to be condenſed on the ſides of the glaſs; which, in both caſes, was in a few minutes reabſorbed, and which appeared to be precipitated by being deprived of its heat by the expanded air.

4. A hole, about the ſize of a crow-quill, was bored into a large air-veſſel placed at the commencement of the principal pipe of the water-works of Derby. There are four pumps worked by a water-wheel, the water of which is firſt thrown into the lower part of this air-veſſel, and riſes from thence to a reſervoir about 35 or 40 feet above the level; ſo that the water in this veſſel is conſtantly in a ſtate of compreſſion. Two thermometers were previouſly ſuſpended on the leaden air-veſſel, that they might aſſume the temperature of it, and as ſoon as the hole above mentioned was opened, had their bulbs applied to the ſtream of air which iſſued out; the conſequence of which was, that the mercury ſunk four degrees in each. This ſinking of the mercury could not be aſcribed to any evaporation of moiſture from their ſurfaces, as it was ſeen both in exhauſting and admitting the air into the exhauſted receiver mentioned in the laſt experiment, that the vapour which it previouſly contained was depoſited during its expanſion.

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5. There is a curious phenomenon obſerved in the fountain of Hiero, conſtructed on a very large ſcale, in the Chemnicenſian mines in Hungary. In this machine the air, in a large veſſel, is compreſſed by a column of water 260 feet high; a ſtop-cock is then opened; and as the air iſſues with great vehemence, and in conſequence of its previous condenſation becomes immediately much expanded, the moiſture it contains is not only precipitated, as in the exhauſted receiver abovementioned, but falls down in a ſhower of ſnow, with iſicles adhering to the noſe of the cock. See Phil. Tranſ. vol. 52.

25 His concluſions with regard to cold on the tops of mountains.

From this phenomenon, as well as the four experiments above related, Mr Darwin thinks "there is good reaſon to conclude, that in all circumſtances where air is mechanically expanded, it becomes capable of attracting the fluid matter of heat from other bodies in contact with it.

"Now, (continues he) as the vaſt region of air which ſurrounds our globe is perpetually moving along its ſurface, climbing up the ſides of mountains, and deſcending into the valleys; as it paſſes along, it muſt be perpetually varying the degree of heat according to the elevation of the country it traverſes: for, in riſing to the ſummits of mountains, it becomes expanded, having ſo much of the preſſure of the ſuperincumbent atmoſphere taken away; and when thus expanded, it attracts or abſorbs heat from the mountains in contiguity with it; and, when it deſcends into the valleys, and is compreſſed into leſs compaſs, it again gives out the heat it has acquired to the bodies it comes in contact with. The ſame thing muſt happen to the higher regions of the atmoſphere, which are regions of perpetual froſt, as has lately been diſcovered by the aerial navigators. When large diſtricts of air, from the lower parts of the atmoſphere, are raiſed two or three miles high, they become ſo much expanded by the great diminution of the preſſure over them, and thence become ſo cold, that hail or ſnow is produced by the precipitation of the vapour: and as there is, in theſe high regions of the atmoſphere, nothing elſe for the expanded air to acquire heat from after it has parted with its vapour, the ſame degree of cold continues, till the air, on deſcending to the earth, acquires its former ſtate of condenſation and of warmth.

"The Andes, almoſt under the line, reſts its baſe on burning ſands; about its middle height is a moſt pleaſant and temperate climate covering an extenſive plain, on which is built the city of Quito; while its forehead is encircled with eternal ſnow, perhaps coeval with the mountain. Yet, according to the accounts of Don Ulloa, theſe three diſcordant climates ſeldom encroach

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croach much on each other's territories. The hot winds below, if they aſcend, become cooled by their expanſion; and hence they cannot affect the ſnow upon the ſummit; and the cold winds that ſweep the ſummit, become condenſed as they deſcend, and of temperate warmth before they reach the fertile plains of Quito."

26 Difficulties ſtill remain on the ſubject.

Notwithſtanding all theſe explanations, however, ſeveral very conſiderable difficulties remain with regard to the heat and cold of the atmoſphere. That warm air ſhould always aſcend; and thus, when the ſource of heat is taken away by the abſence of the ſun, that the ſtratum of atmoſphere lying immediately next to the earth ſhould be ſomewhat colder than that which lies a little farther up; is not at all to be wondered at. We have an example ſomewhat ſimilar to this in the potter's kiln; where, after the veſſels have been intenſely heated for ſome time, and the fire is then withdrawn, the cooling always begins at bottom, and thoſe that ſtand lowermoſt will often be quite black, while all the upper part of the furnace and the veſſels next to to it, are of a bright red. It doth not, however, appear, why ſuch degrees of cold ſhould take place at the ſurface of the earth as we ſometimes meet with. It is, beſides, no uncommon thing to meet with large ſtrata in the upper regions of the atmoſphere, remarkable for their cold, while others are warmer than thoſe at the ſurface; as we have been aſſured of by the teſtimony of ſeveral aerial navigators. It is alſo difficult to ſee why the air which has once aſcended, and become rarefied to any extreme degree, ſhould afterwards deſcend among a denſer fluid of ſuperior gravity, though indeed the atmoſpherical currents by which this fluid is continually agitated may have conſiderable effect in this way. See the article WINDS. See alſo HEAT, COLD, CONGELATION, CONDENSATION, &c.

For the quantity of water contained in the atmoſphere, ſee the articles HYGROMETER, CLOUDS, VAPOUR, &c. For the cauſe of the elaſticity of the atmoſphere, ſee ELASTICITY; and for an explanation of its various operations, ſee METEOROLOGY. See alſo HAIL, RAIN, SNOW, &c.

The uſes of the atmoſphere are ſo many and ſo various that it is impoſſible to enumerate them. One of the moſt eſſential is its power of giving life to vegetables, and ſupporting that of all animated beings. For the latter purpoſe however, it is not in all places equally proper: we ſhall therefore conclude this article with ſome remarks on

27 Of the ſalubrity of the atmoſphere.

The Salubrity of the ATMOSPHERE.——The air on the tops of mountains is generally more ſalubrious than that in pits. Denſe air indeed is always more proper for reſpiration than ſuch as is more rare; yet the air on mountains, though much more rare, is more free from phlogiſtic vapours than that of pits. Hence it has been found, that people can live very well on the tops of mountains, where the barometer ſinks to 15 or 16 inches. M. de Sauſſure, in his journey upon the Alps, having obſerved the air at the foot, on the middle, and on the ſummits of various mountains, obſerves, that the air of the very low plains ſeems to be the leſs ſalubrious; that the air of very high mountains is neither very pure, nor, upon the whole, ſeems ſo fit for the lives of men, as that of a certain height above the level of the ſea, which he eſtimates to be about 200 or 300 toiſes, that is, about 430 or 650 yards. Atmoſphere.

Dr White, in the lxviiith vol. of the Phil. Tranſ. giving an account of his experiments on air made at York, ſays, that the atmoſpherical air was in a very bad ſtate, and indeed in the worſt he had ever obſerved it, the 13th of September 1777; when the barometer ſtood at 30.30, the thermometer at 69°; the weather being calm, clear, and the air dry and ſultry, no rain having fallen for above a fortnight. A ſlight ſhock of an earthquake was perceived that day.

The air of a bed-room at various times, viz. at night, and in the morning after ſleeping in it, has been examined by various perſons; and it has been generally found, that after ſleeping in it the air is leſs pure than at any other time. The air of privies, even in calm weather has not been found to be ſo much phlogiſticated as might have been expected, notwithſtanding its diſagreeable ſmell.

From this and other obſervations, it is thought that the exhalations of human excrements are very little if at all injurious, except when they become putrid, or proceed from a diſeaſed body; in which caſe they infect the air very quickly.

28 Dr Ingenhouſz's experiments.

Dr Ingenhouſz, ſoon after he left London, ſent an account of his experiments made in the year 1779 upon the purity of the air at ſea and other parts; which account was read at the Royal Society the 24th of April 1780, and is inſerted in the lxxth vol. of the Phil. Tranſ. His firſt obſervations were made on board a veſſel in the mouth of the Thames, between Sheerneſs and Margate, where he found that the air was purer than any other ſort of common air he had met with before. He found that the ſea-air taken farther from the land, viz. between the Engliſh coaſt and Oſtend, was not ſo pure as that tried before; yet this inferior purity ſeems not to take place always. The Doctor's general obſervations, deduced from his numerous experiments, are, "That the air at ſea, and cloſe to it, is in general purer, and fitter for animal life, than the air on the land, though it ſeems to be ſubject to ſome inconſiſtency in its degree of purity with that of the land: That probably the air will be found in general much purer far from the land than near the ſhore, the former being never ſubject to be mixed with land air."

The Doctor in the ſame paper tranſcribes a journal of experiments, ſhowing the degree of purity of the atmoſphere in various places, and under different circumſtances; which we ſhall inſert here in an abridged manner.

29 His Journal of the purity of the air in different places.

The method uſed in thoſe experiments, was to introduce one meaſure of common air into the eudiometer-tube, and then one meaſure of nitrous air. The moment that theſe two ſorts of elaſtic fluids came into contact, he agitated the tube in the water-trough, and then meaſured the diminution, expreſſing it by hundredth parts of a meaſure; thus, when he ſays that ſuch air was found to be 130, it ſignifies, that after mixing one meaſure of it with one of nitrous air, the whole mixed and diminiſhed quantity was 130 hundredths of a meaſure, viz. one meaſure and 30 hundredths of a meaſure more.

"The different degrees of ſalubrity of the atmoſphere,

Atmo-sphere.

sphere, as I found it in general in my country-house at Southal-Green, ten miles from London, from June to September, lay between 103 and 109. I was surprised when, upon my return to town to my former lodgings in Pall-Mall Court, I found the common air purer in general in October than I used to find it in the middle of summer in the country; for on the 22d of October, at nine o'clock in the morning, the weather being fair and frosty, I found that one measure of common air, and one of nitrous air, occupied 100 subdivisions in the glass-tube, or exactly one measure. That very day, at two o'clock in the afternoon (it being then rainy weather), the air was somewhat altered for the worse. It gave 102. October the 23d, it being rainy weather, the air gave 102. October the 24th, the weather being serene, the air at nine o'clock in the morning gave 100. October the 25th, the sky being cloudy at 11 o'clock in the morning, the air gave 102. At 11 o'clock at night, from five different trials, it gave 105. October the 26th, the weather being very dark and rainy, the air gave 105, as before."

The air at Ostend was found by the Doctor to be generally very good, giving between 94 and 98. At Bruges, the air taken at seven o'clock at night gave 103. November the 8th, the air at Ghent at three in the afternoon gave 03.

November the 12th, the air of Brussels at seven o'clock P. M. gave 105¼. The next day the air of the lower part of the same city gave 106; that of the highest appeared to be purer, as it gave 104; which agrees with the common popular observation. November the 14th, both the air of the highest and that of the lowest part of the city appeared to be of the same goodness, giving 103. The weather was frosty.

November the 22d, the air of Antwerp in the evening gave 109¼; the weather being rainy, damp, and cold. November the 23d, the air of Breda gave 106. The next day about 11 o'clock the air gave 102; the weather being fair, cold, and inclining to frost. At seven o'clock it gave 103. Next day, being the 25th, the air gave 104; the weather being cold and rainy. The 26th it gave 103; the weather being very rainy, cold, and stormy. November the 27th, the air at the Moordyke close to the water gave 101¼; the weather being fair and cold, but not frosty. This spot is reckoned very healthy. November the 28th, the air of Rotterdam gave 103; the weather being rainy and cold. November the 29th, the air of Delft gave 103; the weather being stormy and rainy.

November the 30th, the air of the Hague gave 104; the weather being cold, and the wind northerly. The first of December the weather underwent a sudden change; the wind becoming southerly and stormy, and the atmosphere becoming very hot. The day after, Fahrenheit's thermometer stood at 54°; and the common air being repeatedly and accurately tried gave 116; and that preserved in a glass phial from the preceding day gave 117; and that gathered close to the sea gave 115.

December the 4th, the air of Amsterdam gave 103; the weather being rainy, windy, and cold. The day after the weather continuing nearly the same, the air gave 102. December the 10th, the air of Rotterdam gave 101; the weather being rainy. December the 12th, being in the middle of the water between Dort and the Moordyke, the air gave 109; the weather being remarkably dark, rainy, and windy. December the 13th, the air of Breda in the morning gave 109; the weather continuing as the day before. And in the afternoon, the air gave 106¼; the weather having cleared up. December the 16th, the air of the lower part of the city of Antwerp gave 105, that of the higher part 104; the weather being rainy and temperate. December the 17th, the air of Antwerp gave 107; the weather continuing nearly as in the preceding day. December the 19th, the air of Brussels gave 109; the weather being rainy, windy, and rather warm. December the 21st, the air of Brussels gave 106; the weather being dry and cold. The next day the air and weather continued the same. December the 23d, the air of Mons gave 104; the weather being rainy and cold. December the 24th, the air near Bouchain gave 104¼; the weather being cloudy and cold. December the 25th, the air of Peronne gave 102¼; the weather being frosty. December the 26th, the air of Cuvilli gave 103; the weather frosty. December the 27th, the air of Senlis gave 102¼; the weather frosty. December the 29th, the air of Paris gave 103; the weather frosty. 1780, January the 8th, the air of Paris gave 100; the weather frosty. January the 13th, the air of Paris gave 98; hard frost.

Atmo-sphere.

30 Apparatus with which his experiments were made.

Thus far with Dr Ingenhousz's observations. His apparatus was a very portable one, made by Mr Martin, which in reality is the eudiometer-tube and measure as used by Mr Fontana before he made his last improvement. "The whole of this apparatus (says Dr Ingenhousz) was packed up in a box about ten inches long, five broad, and three and a half high. The glass-tube or great measure, which was 16 inches long, and divided in two separate pieces, lay in a small compass, and could be put together by brass screws adapted to the divided extremities. Instead of a water-trough, such as is used commonly, I made use of a small round wooden tube, &c."

31 Fontana's opinions on the subject.

The Abbé Fontana, who has made a great number of very accurate experiments upon this subject, gives his opinion in the following words: "I have not the least hesitation in asserting, that the experiments made to ascertain the salubrity of the atmospherical air in various places in different countries and situations, mentioned by several authors, are not to be depended upon; because the method they used was far from being exact (A), the elements or ingredients for the experiment were unknown and uncertain, and the results very different from one another.

"When all the errors are corrected, it will be found that the difference between the air of one country and that of another, at different times, is much less than what is commonly believed; and that the great differences found by various observers are owing to the fallacious effects of uncertain methods. This I advance from experience; for I was in the same error. I found very

(A) It is plain that Dr Ingenhousz's method is not implied in this remark: since the Doctor's experiments were made long after, and the method used by him was properly that of Mr Fontana.

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very great differences between the reſults of the experiments of this nature which ought to have been ſimilar; which diverſities I attributed to myſelf, rather than to the method I then uſed. At Paris I examined the air of different places at the ſame time, and eſpecially of thoſe ſituations where it was moſt probable to meet with infected air, becauſe thoſe places abounded with putrid ſubſtances and impure exhalations; but the differences I obſerved were very ſmall, and much leſs than what could have been ſuſpected, for they hardly arrived to one-fiftieth of the air in the tube. Having taken the air of the hill called *Mount Valerian*, at the height of about 500 feet above the level of Paris, and compared it with the air of Paris taken at the ſame time, and treated alike, I found the former to be hardly one-thirtieth better than the latter.

"In London I have obſerved almoſt the ſame. The air of Iſlington and that of London ſuffered an equal diminution by the mixture of nitrous air; yet the air of Iſlington is eſteemed to be much better. I have examined the air of London taken at different heights (for inſtance, in the ſtreet, at the ſecond floor, and at the top of the adjoining houſes), and have found it to be of the ſame quality. Having taken the air at the iron gallery of St Paul's cupola, at the height of 313 feet above the ground, and likwiſe the air of the ſtone gallery, which is 202 feet below the other; and having compared theſe two quantities of air with that of the ſtreet adjoining, I found that there was ſcarce any ſenſible difference between them, although taken at ſuch different heights.

"In this experiment a circumſtance is to be conſidered, which muſt have contributed to render the abovementioned differences more ſenſible: this is, the agitation of the air of the cupola; for there was felt a pretty briſk wind upon it, which I obſerved to be ſtronger and ſtronger the higher I aſcended; whereas in the ſtreet, and indeed in all the ſtreets I paſſed through, there was no ſenſible wind to be felt. This experiment was made at four in the afternoon, the weather being clear. The quickſilver in the barometer at that time was 28,6 inches high, and Fahrenheit's thermometer ſtood at 54°."

A few lines after, Mr Fontana proceeds thus:—"From this we clearly ſee, how little the experiments hitherto publiſhed about the differences of common air are to be depended upon. In general, I find that the air changes from one time to another; ſo that the differences between them are far greater than thoſe of the airs of different countries or different heights. For inſtance, I have found that the air of London in the months of September, October, and November, 1778, when treated with the nitrous air, gave II,I, 1,90, and II,II, 2,25, which is a mean reſult of many experiments which differed very little from each other. The 26th day of November laſt, I found the air for the firſt time much better, for it gave II,I 1,80, and II,II, 2,20; but the 14th of February 1779, the air gave II,I, 1,69, and II,II, 2,21; from whence it appears, that the air of this 14th of February was better than it had been ſix months before. There can be no doubt of the accuracy of the experiments, becauſe I compared the air taken at different times with that which I had firſt uſed in the month of September, and which I had preſerved in dry glaſs-bottles accurately ſtopped."

Atmoſphere || Atooi.

This difference in the purity of the air at different times, Mr Fontana farther remarks, is much greater than the difference between the air of the different places obſerved by him: notwithſtanding this great change, as he obſerved, and as he was informed by various perſons, no particular change of health in the generality of people, or facility of breathing, was perceived.

Mr Fontana laſtly concludes with obſerving, that "Nature is not ſo partial as we commonly believe. She has not only given us an air almoſt equally good every where at every time, but has allowed us a certain latitude, or a power of living and being in health in qualities of air which differ to a certain degree. By this I do not mean to deny the exiſtence of certain kinds of noxious air in ſome particular places; but only ſay, that in general the air is good every where, and that the ſmall differences are not to be feared ſo much as ſome people would make us believe. Nor do I mean to ſpeak here of thoſe vapours and other bodies which are accidentally joined to the common air in particular places, but do not change its nature and intrinſical property. This ſtate of the air cannot be known by the teſt of nitrous air; and thoſe vapours are to be conſidered in the ſame manner as we ſhould conſider ſo many particles of arſenic ſwimming in the atmoſphere. In this caſe it is the arſenic, and not the degenerated air, that would kill the animals who ventured to breathe it."

ATOCK, The capital of a province of the ſame name in the dominions of the Great Mogul. It is ſeated on a point of land where two large rivers meet, and is one of the beſt fortreſſes the Mogul has; but formerly nobody was permitted to enter it without a paſſport from the Mogul himſelf. E. Long. 72. 10. N. Lat. 32. 20.

ATOM, in philoſophy, a particle of matter, ſo minute, as to admit of no diviſion. Atoms are the *minima naturæ*, and are conceived as the firſt principles or component parts of all phyſical magnitude.

ATOMICAL PHILOSOPHY, or the doctrine of atoms, a ſyſtem which, from the hypotheſis that atoms are endued with gravity and motion, accounted for the origin and formation of things. This philoſophy was firſt broached by Moſchus, ſome time before the Trojan war; but was much cultivated and improved by Epicurus; whence it is denominated the *Epicurean philoſophy*. See EPICUREAN.

ATONEMENT. See EXPIATION.

ATONY, in medicine, a defect of tone or tenſion, or a laxity or debility of the ſolids of the body.

ATOOI, one of the Sandwich iſlands, ſituated in E. Long. 200. 20. N. Lat. 21. 57. Towards the north-eaſt and north-weſt, the face of the country is ragged and broken; but to the ſouthward it is more even. The hills riſe from the ſea-ſide with a gentle acclivity, and at a little diſtance back are covered with wood. Its produce is the ſame with that of the other iſlands of this cluſter; but its inhabitants greatly excel the people of all the neighbouring iſlands in the management of their plantations. In the low grounds, contiguous to the bay wherein our navigators anchored,

Atooi. ed, theſe plantations were regularly divided by deep ditches; the fences were formed with a neatneſs approaching to elegance, and the roads through them were finiſhed in ſuch a manner as would have reflected credit even on an European engineer.

The iſland is about 300 miles in circumference. The road, or anchoring-place, which our veſſels occupied, is on the ſouth-weſt ſide of the iſland, about two leagues from the weſt end, before a village named Wymoa. As far as was ſounded, the bank was free from rocks; except to the caſtward of the village, where there projects a ſhoal on which are ſome rocks and breakers. This road is ſomewhat expoſed to the trade-wind; notwithſtanding which defect, it is far from being a bad ſtation, and greatly ſuperior to thoſe which neceſſity continually obliges ſhips to uſe, in countries where the winds are not only more variable but more boiſterous; as at Madeira, Teneriffe, the Azores, &c. The landing too is not ſo difficult as at moſt of thoſe places; and, unleſs in very bad weather, is always practicable. The water in the neighbourhood is excellent, and may be conveyed with eaſe to the boats. But no wood can be cut at any convenient diſtance, unleſs the iſlanders could be prevailed upon to part with the few etooa trees (*cordia ſebeſtina*) that grow about their villages, or a ſpecies called *dooe dooe*, which grows farther up the country. The ground, from the wooden part to the ſea, is covered with an excellent kind of graſs, about two feet in height, which ſometimes grows in tufts, and appeared capable of being converted into abundant crops of fine hay. But on this extenſive ſpace not even a ſhrub grows naturally.

Beſides taro, the ſweet potatoe, and other ſimilar vegetables uſed by our crews as refreſhments, among which were at leaſt five or ſix varieties of plantains, the iſland produces bread-fruit; which, however, ſeems to be ſcarce. There are alſo a few cocoa palms; ſome yams; the kappe of the Friendly iſlands, or Virginian arum; the etooa tree, and odoriferous gardenia or cape jaſmine. Our people alſo met with ſeveral trees of the dooe dooe, that bear the oily nuts, which are ſtuck upon a kind of ſkewer and made uſe of as candles. There is a ſpecies of ſida, or Indian mallow; alſo the morinda citrifolia, which is here called *none*; a ſpecies of convolvulus; the ava or intoxicating pepper, beſides great quantities of gourds. Theſe laſt grow to a very large ſize, and are of a remarkable variety of ſhapes, which are perhaps the effect of art.

The ſcarlet birds, which were brought for ſale, were never met with alive; but one ſmall one was ſeen, about the ſize of a canary bird, of a deep crimſon colour; alſo a large owl, two brown hawks or kites, and a wild duck. Other birds were mentioned by the natives; among which were the otoo, or blueiſh heron, and the torata, a ſort of of whimbrel. It is probable that the ſpecies of birds are numerous, if we may judge by the quantity of fine yellow, green, and ſmall, velvet-like, blackiſh feathers uſed upon the cloaks and other ornaments worn by theſe people. Fiſh, and other productions of the ſea, were to appearance not various. The only tame or domeſtic animals found here were hogs, dogs, and fowls, which were all of the ſame kind that had been met with at the iſlands of the South Pacific. There were alſo ſmall lizards, and ſome rats.

The inhabitants of Atooi are of the middle ſize, and in general ſtoutly made. They are neither remarkable for a beautiful ſhape nor for ſtriking features. Their viſage, particularly that of the women, is ſometimes round, but others have it long; nor can it juſtly be ſaid, that they are diſtinguiſhed as a nation by any general caſt of countenance. Their complexion is nearly of a nut brown; but ſome individuals are of a darker hue. They are far from being ugly, and have, to all appearance, few natural deformities of any kind. Their ſkin is not very ſoft nor ſhining; but their eyes and teeth are, for the moſt part, pretty good. Their hair in general is ſtraight; and though its natural colour is uſually black, they ſtain it, as at the Friendly and other iſlands. They are active, vigorous, and moſt expert ſwimmers; leaving their canoes upon the moſt frivolous occaſion, diving under them, and ſwimming to others, though at a conſiderable diſtance. Women with infants at the breaſt, when the ſurf was ſo high as to prevent their landing in the canoes, frequently leapt overboard, and ſwam to the ſhore, without endangering their little ones. They appeared to be of a frank, chearful diſpoſition; and are equally free from the fickle levity which characterizes the inhabitants of Otaheite, and the ſedate caſt which is obſervable among many of thoſe of Tongataboo. They ſeem to cultivate a ſociable intercourſe with each other; and, except the propenſity of thieving, which is as it were innate in moſt of the people in thoſe ſeas, they appeared extremely friendly. It was pleaſing to obſerve with what affection the women managed their infants, and with what alacrity the men contributed their aſſiſtance in ſuch a tender office; thus diſtinguiſhing themſelves from thoſe ſavages who conſider a wife and a child as things rather neceſſary than deſirable or worthy of their regard and eſteem. From the numbers that were ſeen aſſembled at every village in coaſting along, it was conjectured that the inhabitants of this iſland are pretty numerous. Including the ſtraggling houſes, it was computed there might perhaps be, in the whole iſland, ſixty ſuch villages as that near which our ſhips anchored; and allowing five perſons to each houſe, there would be in every village five hundred, or thirty thouſand upon the iſland. This number is by no means exaggerated; for there were ſometimes three thouſand people at leaſt collected upon the beach, when it could not be ſuppoſed that above a tenth part of the natives were preſent. Atooi, Atra.

ATRA BILIS, BLACK BILE, or MELANCHOLY. According to the ancients it hath a twofold origin: 1ſt, From the groſſer parts of the blood, and this they called the *melancholy humour*. 2d, From yellow bile being highly concocted. Dr Percival, in his Eſſays Med. and Exp. ſuggeſts, that it is the gall rendered acrid by a ſtagnation in the gall-bladder, and rendered viſcid by the abſorption of its fluid parts. Bile in this ſtate diſcharged into the duodenum, occaſions univerſal diſturbance and diſorder until it is evacuated; it occaſions violent vomiting, or purging, or both; and previous to this the pulſe is quick, the head aches, a delirium comes on, a hiccough, intenſe thirſt, inward heat, and a fetid breath. Some deſcribe this kind of bile as being acid, harſh, corroding, and, when poured on the ground, bubbling up, and raiſing the earth after the manner of a ferment. Dr Percival ſays, that by the

Atra dies, Atractylis.

the uſe of the *infuſ. ſenæ limoniet.* warmed with the *tinct. columb.* he had checked the vomitings occaſioned by this matter.

ATRA DIES, in antiquity, denotes a *fatal day* whereon the Romans received ſome memorable defeat. The word literally imports *a black day;* a denomination taken from the colour, which is the emblem of death and mourning. Whence the Thracians had a cuſtom of marking all their happy days with white ſtones or calculi, and their unhappy days with black ones: which they caſt, at the cloſe of each day, into an urn. At the perſon's death the ſtones were taken out; and from a compariſon of the numbers of each complection, a judgment was made of the felicity or infelicity of his courſe of life. The *dies atræ* or *artri*, were afterwards denominated *nefaſti*, and *poſteri*. Such in particular was the day when the tribunes were defeated by the Gauls, at the river Allia, and loſt the city; alſo that whereon the battle of Cannæ was fought; and ſeveral others marked in the Roman calendar as *atræ* or unfortunate.

ATRACTYLIS, DISTAFF THISTLE: A genus of the polygamia æqualis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ-capitatæ*. The corolla is radiated; and each of the little corollæ of the radius has five teeth.

Species. 1. The cancellata, or ſmall cnicus, is an annual plant riſing about eight or nine inches high, with a ſlender ſtem, garniſhed with hoary leaves, having ſpines on their edges. At the top of theſe branches are ſent out two or three ſlender ſtalks, each terminated by a head of flowers like thoſe of the thiſtle. The empalement is curiouſly netted over, and is narrow at the top, but ſwelling below; and contains many florets of a purpliſh colour. Theſe are each ſucceeded by a ſingle downy ſeed, which in cold years do not ripen in Britain. 2. The humilis, or purple prickly cnicus, riſes about a foot high, with indented leaves, having ſmall ſpines on their edges. The upper part of the ſtalk is divided into two or three ſlender branches, each ſupporting a head of purple flowers, having rays incloſed in a ſcaly empalement. The flowers appear in June; but unleſs the ſeaſon is warm, the ſeeds will not ripen in Britain. 3. The gummifera, or prickly gum-bearing cnicus, known among phyſicians by the name of *carline thiſtle*. This ſends out many narrow leaves, which are deeply ſerrated, and armed with ſpines on their edges. Theſe lie cloſe on the ground; and between them the flower is ſituated, without a ſtalk, and having many florets incloſed in a prickly empalement. Thoſe on the border are white; but ſuch as compoſe the diſk are of a yellowiſh colour. It flowers in July, but never perfects ſeeds in Britain.

Culture. All theſe plants are natives of the warm parts of Europe, as Spain, Sicily, and the Archipelago iſlands, from whence their ſeeds muſt be procured. They muſt be ſown upon an open bed of light earth, where the plants are to remain; and when the plants come up, they ſhould be thinned, ſo as to leave them three or four inches aſunder. The roots of the ſecond will laſt two or three years, and the third is a perennial plant.

Medicinal Uſes. The root of the third ſort was formerly uſed as a warm diaphoretic and alexipharmic; but it never came much into uſe in Britain, and the preſent practice has entirely rejected it. The root is about an inch thick, externally of a pale ruſty brown colour, corroded as it were in the ſurface; and perforated with numerous ſmall holes, ſo as to appear worm-eaten when cut. It has a ſtrong ſmell; and a ſubacid, bitteriſh, and weakly aromatic taſte. Frederic Hoffman the elder relates, that he has obſerved a decoction of it in broth to occaſion vomiting.

Atræti | Atreus.

ATRÆTI, in medicine, infants having no perforation in the anus, or perſons imperforated in the vagina or urethra.

ATRAGENE, in botany; A genus of the polyandria order belonging to the polygamia claſs of plants. The calyx has four leaves; the petals are 12; and the ſeeds are candated. There are three ſpecies, all natives of the eaſt.

ATRAPHAXIS: A genus of the dygnia order, belonging to the hexandria claſs of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. The calyx has two leaves; the petals are two, and ſinuated; and there is but one ſeed. There are two ſpecies, both natives of warm countries, but meriting no particular deſcription.

ATREBATII, a people of Britain, ſeated next to the Bibroci, in part of Berkſhire and part of Oxfordſhire. This was one of thoſe Belgic colonies which had come out of Gaul into Britain, and there retained their ancient name. For the Atrebatii were a tribe of the Belgæ, who inhabited that country which is now called Artois. They are mentioned by Cæſar among the nations which compoſed the Belgic confederacy againſt him; and the quota of troops which they engaged to furniſh on that occaſion was 15,000. Comius of Arras was a king or chieftain among the Atrebatii in Gaul in Cæſar's time: and he ſeems to have poſſeſſed ſome authority, or at leaſt ſome influence, over our Atrebatii in Britain; for he was ſent by Cæſar to perſuade them to ſubmiſſion. This circumſtance makes it probable that this colony of the Atrebatii had not been ſettled in Britain very long before that time. The Atrebatii were among thoſe Britiſh tribes which ſubmitted to Cæſar; nor do we hear of any remarkable reſiſtance they made againſt the Romans at their next invaſion under Claudius. It is indeed probable, that before the time of this ſecond invaſion they had been ſubdued by ſome of the neighbouring ſtates, perhaps by the powerful nation of the Cattivellauni, which may be the reaſon they are ſo little mentioned in hiſtory. Calliva Attrebatum, mentioned in the ſeventh, twelfth, thirteenth, and fourteenth itinera of Antoninus, and called by Ptolemy *Calcua*, ſeems to have been the capital of the Atrebatii; though our antiquaries differ in their ſentiments about the ſituation of this ancient city, ſome of them placing it at Wallingford, and others at Ilcheſter.

ATREUS, in fabulous hiſtory, the ſon of Pelops and Hippodamia, and the father of Agamemnon and Menelaus, is ſuppoſed to have been king of Mycenæ and Argos about 1228 years before the Chriſtian æra. He drove his brother Thyeſtes from court, for having a criminal commerce with Ærope his wife; but underſtanding that he had had two children by her, he ſent for him again, and made him eat them; at

Atri
Atriplex.

which horrid action the ſun, it is ſaid, withdrew his light.

ATRI, a town of Italy, in the farther Abruzzo in the kingdom of Naples, with the title of a duchy; it is the ſee of a biſhop, and is ſeated on a craggy mountain, four miles from the Adriatic Sea. E. Long. 13. 8. N. Lat 42. 45.

ATRIENSES, in antiquity, a kind of ſervants or officers in the great families at Rome, who had the care and inſpection of the atria and the things lodged therein.

Theſe are otherwiſe called atriarii, though ſome make a diſtinction between *atrienſes* and *atriarii*; ſuggeſting that the latter were an inferior order of ſervants, perhaps aſſiſtants of the atrienſes, and employed in the more ſervile offices of the atrium, as to attend at the door, ſweep the area, &c.

The artienſes are repreſented as ſervants of authority and command over the reſt: they acted as procurators, or agents, of their maſter, in ſelling his goods, &c. To their care were committed the ſtatues and images of the maſter's anceſtors, &c. which were placed round the atrium; and which they carried in proceſſion at funerals, &c.

In the villas, or country-houſes, the atrienſes had the care of the other furniture and utenſils, particularly thoſe of metal, which they were to keep bright from ruſt. Other things they were to hang from time to time in the ſun, to keep them dry, &c. They were cloathed in a ſhort white linen habit, to diſtinguiſh them, and prevent their loitering from home.

ATRIP, in nautical language, is applied either to the anchor or ſails. The anchor is atrip, when it is drawn out of the ground in a perpendicular direction, either by the cable or buoy-rope. The top-ſails are atrip, when they are hoiſted up to the maſt-head, or to their utmoſt extent.

ATRIPLEX, ORACH, or ARACH: A genus of the moncœcia order, belonging to the polygamia claſs of plants; and, in the natural method, ranking under the 12th order, *Holoraceæ*. The calyx of the hermaphrodite flower has five leaves: there is no corolla; the ſtamina are five, and the ſtylus is bifid; the ſeed is one, and depreſſed.

Species. 1. The hortenſis, or garden orach, was formerly cultivated in gardens, and uſed as a ſubſtitute for ſpinage, to which it is ſtill preferred by ſome, tho' in general it is diſliked by the Engliſh; however, it ſtill maintains its credit in France, as alſo in the northern parts of England. There are three or four varieties of this plant, whoſe only difference is their colour; one is a deep green, another a dark purple, and a third with green leaves and purple borders. 2. The halimus, or broad-leaved orach, was formerly cultivated in gardens as a ſhrub, by ſome formed into hedges, and conſtantly ſheared to keep them thick: but this is a purpoſe to which it is by no means adapted, as the ſhoots grow ſo vigorous, that it is impoſſible to keep the hedge in any tolerable order; and, what is worſe, in ſevere winters the plants are often deſtroyed. 3. The petulacoides, or ſhrubby ſea-orach, grows wild by the ſea-ſide in many places of Britain. It is a low under-ſhrub, ſeldom riſing above two feet and an half, or at moſt three feet high; but becomes very buſhy. This may have a place in gardens among other low ſhrubs, where it will make a pretty diverſity. Beſides theſe, nine other ſpecies are enumerated by botanical writers, but the abovementioned are the moſt remarkable.

Atrium,
Atropa.

Culture, &c. The firſt ſort is annual, ſo muſt be propagated by ſeeds. Theſe are to be ſown at Michaelmas, ſoon after the ſeeds are ripe. The plants require no other culture than to be kept free from weeds, to hoe them when they are about an inch high, and to cut them down when they are too thick, ſo as to leave them about four inches aſunder. When theſe plants are ſown in a rich ſoil, and allowed a good diſtance from each other, the leaves will grow very large, and in this their goodneſs conſiſts. This muſt be eaten whilſt it is young; for when old, the leaves become tough, and are good for nothing. This ſpecies is an article of the materia medica; a decoction of the leaves is recommended in coſtiveneſs, where the patient is of a hot bilious diſpoſition.—The ſecond ſort may be propagated by cuttings. Theſe are to be planted in any of the ſummer months, in a ſhady border; where they will ſoon take root, and be fit againſt the following Michaelmas to tranſplant into thoſe places where they are to remain.—The third ſort requires very little culture. It may be alſo propagated from cuttings, and is to be planted in a poor gravelly ſoil.

ATRIUM, in eccleſiaſtical antiquity, denotes an open place or court before a church, making part of what was called the *narthex* or *antetemple*.

The atrium in the ancient churches was a large area or ſquare plat of ground, ſurrounded with a portico or cloyſter, ſituate between the porch or veſtible of the church, and the body of the church.

Some have miſtakenly confounded the atrium with the porch or veſtible, from which it was diſtinct; others with the narthex, of which it was only a part.

The atrium was the manſion of thoſe who were not ſuffered to enter farther into the church. More particularly, it was the place where the firſt claſs of penitents ſtood to beg the prayers of the faithful as they went into the church.

ATRIUM is alſo uſed, in the cannon law, for the cemetry or church-yard. In this ſenſe we find a law prohibiting buildings to be raiſed in *atrio eccleſiæ*, except for the clergy; which the gloſſary explains thus, *id eſt in cæmeterio*, which includes the ſpace of forty paces around a large church, or thirty round a little church or chapel.

ATROPA, DEADLY NIGHT-SHADE: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 25th order, *Luridæ*. The corolla is campanulated; the ſtamina are diſtant; the berry is globular, and conſiſts of two cells. The ſpecies are five; of which the three following are the moſt remarkable: 1. The belladonna grows wild in many parts of Britain. It hath a perennial root, which ſends out ſtrong herbaceous ſtalks of a purpliſh colour, which riſe to the height of four or five feet, garniſhed with entire oblong leaves, which towards autumn change to a purpliſh colour. The flowers are large, and come out ſingly between the leaves, upon long foot-ſtalks; bell-ſhaped, and of a duſky colour on the out-ſide, but purpliſh within. After the flower is paſt, the germen turns to a large round berry a little flatted at the top. It is firſt green; but when ripe, turns to a ſhining black,

Atropa. black, ſits cloſe upon the empalement, and contains a purple juice of a nauſeous ſweet taſte, and full of ſmall kidney-ſhaped ſeeds. 2. The fruteſcens is a native of Spain, and riſes with a ſhrubby ſtem to the height of ſix or eight feet; dividing into many branches garniſhed with round leaves, in ſhape like thoſe of the ſtorax tree: theſe are placed alternately on the branches. The flowers come out between the leaves on ſhort foot-ſtalks, ſhaped like thoſe of the former, but much leſs; of a dirty yellowiſh colour, with a few brown ſtripes: but theſe are never ſucceeded by berries in Britain. 3. The herbacea, with an herbaceous ſtalk, is a native of Campeachy. This hath a perennial root, which puts forth ſeveral channelled herbaceous ſtalks riſing about two feet; and towards the top they divide into two or three ſmall branches garniſhed with oval leaves four inches long and three broad, having ſeveral prominent tranſverſe ribs on the under ſide. The flowers come out from between the leaves on ſhort foot-ſtalks; they are white, and ſhaped like thoſe of the common ſort, but ſmaller. It flowers in July and Auguſt, but ſeldom ripens its fruit in Britain. 4. The mandragora, or mandrake, which has been diſtinguiſhed into the male and female. The male mandrake has a very large, long, and thick root; it is largeſt at the top or head, and from thence gradually grows ſmaller. Sometimes it is ſingle and undivided to the bottom; but more frequently it is divided into two or more parts. When only parted into two, it is pretended that it reſembles the body and thighs of a man. From this root there ariſe a number of very long leaves, broadeſt in the middle, narrow towards the baſe, and obtuſely pointed at the end; they are of a foot or more in length, and five inches or thereabouts in breadth; they are of a duſky and diſagreeable green colour, and of a very fœtid ſmell. The female mandrake perfectly reſembles the other in its manner of growth; but the leaves are longer and narrower, and of a darker colour, as are alſo the ſeeds and roots. It grows naturally in Spain, Portugal, Italy, and the Levant.

Culture. The firſt ſpecies, which is remarkable for its poiſonous qualities, is very ſeldom admitted in gardens, nor ſhould it ever be cultivated or allowed to grow in thoſe places to which children have acceſs. The other kinds are propagated by ſeeds, and placed in a ſtove, as is requiſite for the more tender plants.

Qualities, &c. The firſt ſpecies, as we have already obſerved, is a ſtrong poiſon. Mr Ray gives a good account of the ſymptoms that follow the taking of it inwardly, by what happened to a mendicant friar upon his drinking a glaſs of mallow wine in which the herb was infuſed. In a ſhort time he became delirious, and ſoon after was ſeized with a grining laughter; then with ſeveral irregular motions, and at laſt with a real madneſs, and ſuch a ſtupidity as thoſe have who are ſottiſhly drunk: but after all he was cured by a draught of vinegar. Buchannan alſo gives an account of the deſtruction of the army of Sweno the Dane, when he invaded Scotland, by mixing a quantity of the belladonna berries with the drink which the Scots were, according to a treaty of truce, to ſupply them with. This ſo intoxicated the Danes, that the Scots fell upon them in their ſleep, and killed the greateſt part of them, ſo that there were ſcarcely men enough left to carry off their king. There have alſo been many inſtances in Britain of children being killed by eating berries of a fine black colour, and about the ſize of a ſmall cherry, which are no other than thoſe of belladonna. When an accident of this kind is diſcovered in time, a glaſs of warm vinegar will prevent the bad effects. Atropa ‖ Attachment.

The third ſpecies has been recommended in caſes of barrenneſs, but without foundation. Its freſh root is a violent purge, the doſe being from ten grains to twenty in ſubſtance, and from half a dram to a dram in infuſion. It has been found to do ſervice in hyſteric complaints; but muſt be uſed with great caution, otherwiſe it will bring on convulſions, and many other miſchievous ſymptoms. It has alſo a narcotic quality. At preſent only the freſh leaves are ſometimes uſed in anodyne and emollient cataplaſms and fomentations. It uſed to be an ingredient in one of the old officinal unguents; but both that and the plant itſelf are now rejected from our pharmacopœias. It ſtill however retains a place in the foreign ones, and may perhaps be conſidered as deſerving farther attention.

Naturaliſts tell ſtrange ſtories of this plant: but ſetting aſide its ſoporiferous virtue, the modern botaniſts will ſcarce warrant any of them, nor even that human figure ordinarily aſcribed to its roots, eſpecially ſince the diſcovery of the artifice of the Charletans in faſhioning it, to ſurpriſe the credulity of the people. The figure given in Plate XCI. however, was taken from a genuine root.

Moſes informs us, (Gen. xxx. 14.) that Reuben, the ſon of Leah, being in the field, happened to find mandrakes, which he brought home to his mother. Rachel had a mind to them, and obtained them from Leah, upon condition that ſhe ſhould conſent that Jacob ſhould be Leah's bedfellow the night following. The term דודאים *dudaim*, here made uſe of by Moſes, is one of thoſe words of which the Jews at this day do not underſtand the true ſignification. Some tranſlate it *violets*, others *lillies*, or *jeſſamine*. Junius calls it *agreeable flowers*; Codurquus makes it *truffle*, or *muſhroom*; and Calmet will have it to be the *citron*. Thoſe that would ſupport the tranſlation of *mandrakes* plead, that Rachel being barren, and having a great deſire to conceive, coveted Leah's mandrakes, it may be preſumed, with a view to its prolific virtues. The ancients have given to mandrakes the name of the *apples of love*, and to Venus the name of *Mandragoritis*; and the Emperor Julian, in his epiſtle to Calixenes, ſays, that he drinks the juice of mandrakes to excite amorous inclinations.

ATROPHY, in medicine, a diſeaſe, wherein the body, or ſome of its parts, does not receive the neceſſary nutriment, but waſte and decay inceſſantly. See MEDICINE-*Index*.

ATROPOS, in fabulous hiſtory, the name of the third of the Parcæ, or Fates, whoſe buſineſs it was to cut the thread of life.

ATTACHMENT, in the law of England, implies the taking or apprehending a perſon by virtue of a writ or precept. It is diſtinguiſhed from an *arreſt*, by proceeding out of a higher court by precept or writ; whereas the latter proceeds out of an inferior court by precept only. An arreſt lies only to the body

Attachment | Attainder.

of a man; whereas an attachment lies often on the goods only, and ſometimes on the body and goods. An attachment by writ differs from *diſtreſs*, in not extending to lands, as the latter does; nor does a diſtreſs touch the body, as an attachment does.

Attachment out of the Chancery, is obtained upon an affidavit made, that the defendant was ſerved with a ſubpœna, and made no appearance; or it iſſues upon not performing ſome order or decree. Upon the return of this attachment by the ſheriff, *quod non eſt inventus in balliva ſua*, another attachment, with a proclamation, iſſues; and if he ſtill refuſes to appear, a commiſſion of rebellion.

Attachment of the Foreſt, is one of the three courts held in the foreſt. The loweſt court is called the *court of attachment*, or *wood-mote court*; the mean, *ſwan-mote*; and the higheſt, the *juſtice in eyre's ſeat*. The court of attachments has its name from the verdurers of the foreſt having no other authority in it, but to receive the attachments of offenders againſt vert and veniſon taken by the foreſters, and to enroll them, that they may be preſented or puniſhed at the next juſtice in eyre's ſeat. This attachment is by three means: by goods and chattels; by body, pledges, or main-prize; or by the body only. This court is held every 40 days throughout the year; and is thence called *forty day's court*.

Foreign Attachment is an attachment of money or goods found within a liberty or city, to ſatisfy ſome creditor within ſuch liberty or city. By the cuſtom of London, and ſeveral other places, a man can attach money or goods in the hands of a ſtranger, to ſatisfy himſelf.

ATTACK, a violent attempt upon any perſon or thing, an aſſault, or the act of beginning a combat or diſpute.

Attack, in the military art, is an effort made to force a poſt, break a body of troops, &c.

Attack of a Seige, is a furious aſſault made by the beſiegers with trenches, covers, mines, &c. in order to make themſelves maſters of a fortreſs, by ſtorming one of its ſides. If there are two or three attacks made at the ſame time, there ſhould be a communication betwixt them. See War.

ATTACOTTI, an ancient people of Britain, mentioned by Ammianus, Marcellinus and St Jerome, as well as in the *Notitia Imperii*. They are repreſented as allies and confederates of the Scots and Picts, and therefore, probably their neighbours: though their preciſe ſituation has not been determined by antiquaries.

ATTAINDER, in law. When ſentence of death, the moſt terrible and higheſt judgment in our laws, is pronounced, the immediate inſeparable conſequence by the common law is attainder. For when it is now clear beyond all diſpute, that the criminal is no longer fit to live upon the earth, but is to be exterminated as a monſter and a bane to human ſociety, the law ſets a note of infamy upon him, puts him out of its protection, and takes no farther care of him than barely to ſee him executed. He is then called *attaint*, *attinctus*, *ſtained*, or *blackened*. He is no longer of any credit or reputation; he cannot be a witneſs in any court; neither is he capable of performing the functions of another man: for, by an anticipation of his puniſhment, he is already dead in law. This is after judgment: for there is great difference between a man *convicted*, and *attainted*; though they are frequently through inaccuracy confounded together. After conviction only, a man is liable to none of theſe diſabilities: for there is ſtill in contemplation of law a poſſibility of his innocence. Something may be offered in arreſt of judgment: the indictment may be erroneous, which will render his guilt uncertain, and thereupon the preſent conviction may be quaſhed: he may obtain a pardon, or be allowed the benefit of clergy; both which ſuppoſe ſome latent ſparks of merit, which plead in extenuation of his fault. But when judgment is once pronounced, both law and fact conſpire to prove him completely guilty; and there is not the remoteſt poſſibility left of any thing to be ſaid in his favour. Upon judgment, therefore, of death, and not before, the attainder of a criminal commences: or upon ſuch circumſtances as are equivalent to judgment of death; as judgment of outlawry on a capital crime, pronounced for abſconding or fleeing from juſtice, which tacitly confeſſes the guilt: And therefore, upon judgment either of outlawry, or of death, for treaſon or felony, a man ſhall be ſaid to be attainted. Attainder, Attaint.

A perſon attainted of high treaſon forfeits all his lands, tenements, and heriditaments; his blood is corrupted, and he and his poſterity rendered baſe; and this corruption of blood cannot be taken off but by act of parliament.*

Attainders may be reverſed or falſified, (i. e. proved to be falſe) by writ or error, or by plea. If by writ of error, it muſt be by the king's leave, &c.; and when by plea, it may be by denying the treaſon, pleading a pardon by act of parliament, &c.

Perſons may be attainted by act of parliament.—Acts of attainder of criminals have been paſſed in ſeveral reigns, on the diſcovery of plots and rebellions, from the reign of king Charles II. when an act was made for the attainder of ſeveral perſons guilty of the murder of king Charles I. Among acts of this nature, that for attainting Sir John Fenwick, for conſpiring againſt king William, is the moſt remarkable; it being made to attaint and convict him of high treaſon on the oath of one witneſs, juſt after a law had been enacted, "That no perſon ſhould be tried or attainted of high treaſon where corruption of blood is incurred, but by the oath of two lawful witneſſes, unleſs the party confeſs, ſtand mute, &c." Stat. 7 and 8 W. III. cap. 3. But in the caſe of Sir John Fenwick, there was ſomething extraordinary; for he was indicted of treaſon on the oaths of two witneſſes, tho' but only one could be produced againſt him on his trial.

ATTAINT, is a writ that lies after judgment againſt a jury of twelve men that have given falſe verdict in any court of record, in an action real or perſonal, where the debt or damages amount to above 40s. Stat. 5 and 34 Ed. III. c. 7. It is called *attaint*, becauſe the party that obtains it endeavours thereby to ſtain or taint the credit of the jury with perjury, by whoſe verdict he is grieved.

The jury who are to try this falſe verdict muſt be twenty-four, and are called *the grand jury*; for the law wills

* See the articles *Forfeiture* and *Corruption* of Blood.

Attaint ‖ Attalicæ.

wills not that the oath of one jury of twelve men ſhould be attainted or ſet aſide by an equal number, nor by leſs indeed than double the former. And he that brings the attaint can give no other evidence to the grand jury, than what was originally given to the petit. For as their verdict is now trying, and the queſtion is whether or no they did right upon the evidence that appeared to them, the law adjudged it the higheſt abſurdity to produce any ſubſequent proof upon ſuch trial, and to condemn the prior juriſdiction for not believing evidence which they never knew. But thoſe againſt whom it is brought are allowed, in the affirmance of the firſt verdict, to produce new matter: becauſe the petit jury may have formed their verdict upon evidence of their own knowledge, which never appeared in court; and becauſe very terrible was the judgment which the common law inflicted upon them, if the grand jury found their verdict a falſe one. The judgment was, 1. That they ſhould loſe their *liberam legem*, and become for ever infamous. 2. That they ſhould forfeit all their goods and chattels. 3. That their lands and tenements ſhould be ſeized into the king's hands. 4. That their wives and children ſhould be thrown out of doors. 5. That their houſes ſhould be raſed and thrown down. 6. That their trees ſhould be rooted up. 7. That their meadows ſhould be ploughed. 8. That their bodies ſhould be caſt into jail. 9. That the party ſhould be reſtored to all that he loſt by reaſon of the unjuſt verdict. But as the ſeverity of this puniſhment had its uſual effect, in preventing the law from being executed, therefore by the ſtatute 11 Hen. VII. c. 24. revived by 23 Hen. VIII. c. 3. and made perpetual by 13 Eliz. c. 25. it is allowed to be brought after the death of the party, and a more moderate puniſhment was inflicted upon attainted jurors; viz. perpetual infamy, and if the cauſe of action were above L.40 value, a forfeiture of L.20 a-piece by the jurors; or, if under L.40, then L.5 a-piece; to be divided between the king and the party injured. So that a man may now bring an attaint either upon the ſtatute or at common law, at his election; and in both of them may reverſe the former judgment. But the practice of ſetting aſide verdicts upon motion, and granting new trials, has ſo ſuperſeded the uſe of both ſorts of attaints, that there is hardly any inſtance of an attaint later than the 16th century.

ATTAINT, among farriers, a knock or hurt in a horſe's leg, proceeding either from a blow with another horſe's foot, or from an over-reach in froſty weather, when a horſe, being rough-ſhod, or having ſhoes with long caulkers, ſtrikes his hinder feet againſt his fore-leg.

ATTAINTED, in law, is applied to a perſon's being under attainder. See ATTAINDER.

ATTALICÆ VESTES, in antiquity, garments made of a kind of cloth of gold. They took the denomination from Attalus, ſurnamed Philometer, a wealthy king of Pergamus, who was the firſt, according to Pliny, who procured gold to be woven into cloth.

Attalus ‖ Attention.

ATTALUS, the name of ſeveral kings of Pergamus. See PERGAMUS.

ATTELABUS, in zoology, a genus of inſects belonging to the order of coleoptera or beetle-kind. It has four wings, of which the ſuperior are cruſtaceous, and ſerve as a ſheath or cover to the inferior, which are membranous. The head tapers behind, and is inclined; the feelers turn thicker towards the apex. The ſpecies are 13; viz. 1. The coryli is black, with red elytra or cruſtaceous wings. 2. The avellana is black, with the breaſt, feet, and elytra red. 3. The curculionoides is black, with red elytra and breaſt. The above three ſpecies frequent the leaves of the hazel and filbert nut-trees. 4. The ſurinamenſis has a double indentation (or two teeth) in the top of the elytra. It is a native of Surinam. 5. The penſilvanicus is black, with red elytra, a black belt round the middle, and another towards the apex of the elytra. It is a native of Philadelphia. 6. The melanurus is black, with teſtaceous elytra, black at the apex. It is a native of Sweden. 7. The betula has ſaltatory or ſpringy legs, and the whole body is of a dark-red colour. It frequents the leaves of the birch-tree. 8. The formicarius is black, with red elytra, and a double white belt towards the baſe. It is a native of Europe. 9. The ſipylus is green, with a hairy breaſt, and a double yellow belt upon the elytra. 10. The apiarius is bluiſh, with red elytra, and three black belts. It is a native of Germany. 11. The mollis is yellowiſh and hairy, with pale elytra, and three belts. It is a native of Europe. 12. The ceramboides is of a blackiſh red colour, and the elytra is furrowed. It frequents the ſpongy beletus, a ſpecies of muſhroom. 13. The bupreſtoides is of a dark-red colour, with a globular breaſt, and nervous elytra. It is a native of Europe.

ATTENTION, a due application of the ear, or the mind, to any thing ſaid or done, in order to acquire a knowledge thereof. The word is compounded of *ad*, "to," and *tendo*, "I ſtretch."

Attention of mind is not properly an act of the underſtanding; but rather of the will, by which it calls the underſtanding from the conſideration of other objects, and directs it to the thing in hand. Nevertheleſs, our attention is not always voluntary: an intereſting object ſeizes and fixes it beyond the power of controul.

Attention, in reſpect of hearing, is the ſtretching or ſtraining of the *membrana tympani*, ſo as to make it more ſuſceptible of ſounds, and better prepared to catch even a feeble agitation of the air. Or it is the adjuſting the tenſion of that membrance to the degree of loudneſs or lowneſs of the ſound to which we are attentive.

According to the degree of attention, objects make a ſtronger or weaker impreſſion (A). Attention is requiſite

(A) Bacon, in his natural hiſtory, makes the following obſervations. "Sounds are meliorated by the intenſion of the ſenſe, where the common ſenſe is collected moſt to the particular ſenſe of hearing, and the ſight ſuſpended. Therefore ſounds are ſweeter, as well as greater, in the night than in the day; and I ſuppoſe they are ſweeter to blind men than to others; and it is manifeſt, that between ſleeping and waking, when all the ſenſes are bound and ſuſpended, muſic is far ſweeter than when one is fully waking."

Attention, Attenuants

quiſite even to the ſimple act of ſeeing: the eye can take in a conſiderable field at one look; but no object in the field is ſeen diſtinctly but that ſingly which fixes the attention: in a profound reverie that totally occupies the attention, we ſcarce ſee what is directly before us. In a train of perceptions, no particular object makes ſuch a figure as it would do ſingly and apart; for when the attention is divided among many objects, no particular object is intitled to a large ſhare. Hence, the ſtillneſs of night contributes to terror, there being nothing to divert the attention:

Horror ubique animos, ſimul ipſa ſilentia terrent. *Æn.* ii.

Zara. Silence and ſolitude are ev'ry where!
Through all the gloomy ways and iron doors
That hither lead, nor human face nor vice
Is ſeen or heard. A dreadful din was wont
To grate the ſenſe, when enter'd here, from groans
And howls of ſlaves condemn'd, from clink of chains,
And craſh of ruſty bars and creaking hinges;
And ever and anon the ſight was daſh'd
With frightful faces, and the meagre looks
Of grim and ghaſtly executioners.
Yet more this ſtillneſs terrifies my ſoul
Than did that ſcene of complicated horrors.
Mourning Bride, act 5. ſc. 3.

In matters of ſlight importance, attention is moſtly directed by will; and for that reaſon, it is our own fault if trifling objects make any deep impreſſion. Had we power equally to with-hold our attention from matters of importance, we might be proof againſt any deep impreſſion. But our power fails us here: an intereſting object ſeizes and fixes the attention beyond the poſſibility of controul; and while our attention is thus forcibly attached to one object, others may ſolicit for admittance; but in vain, for they will not be regarded. Thus a ſmall misfortune is ſcarce felt in preſence of a greater:

Lear. Thus think'ſt 'tis much, that this contentious ſtorm
Invades us to the ſkin: ſo 'tis to thee:
But where the greater malady is fix'd,
The leſſer is ſcarce felt. Thou'dſt ſhun a bear;
But if thy flight lay tow'rd the roaring ſea,
Thou'dſt meet the bear i' th' mouth. When the mind's free,
The body's delicate: the tempeſt in my mind
Doth from my ſenſes take all feeling elſe,
Save what beats there. *King Lear, act 3. ſc. 5.*

ATTENUANTS, or ATTENUATING *Medicines*, are ſuch as ſubtilize and break the humours into finer parts; and thus diſpoſe them for motion, circulation, excretion, &c.

Attenuating and inciding medicines are of very extenſive uſe in phyſic, and come under different denominations, according to the different effects they produce. Thus, when tenacious and viſcid juices not only ſtagnate in the cavities of the veſſels, but obſtruct the minute ducts of the viſcera and emunctories, theſe medicines, by the inciding and attenuating quality, diſcharge the humours, and remove the obſtructions; for which reaſon they are not improperly called *aperients*.

Attenuants produce ſo great a variety of effects, that it is proper we ſhould be well acquainted with their ſeveral kinds, as appropriated to the ſeveral diſorders, and know which will prove moſt ſerviceable in each. According to Hoffman, the diſſolving and attenuating of viſcid crudities in the ſtomach and *primæ viæ*, is well anſwered by the roots of arum, acorus, pepper, ginger, and the like; as alſo by ſal ammoniac, vitriolated tartar, the fixed alkaline ſalts, and the ſimple or dulcified ſpirit of ſalt. When crude and unconcocted humours are to be evacuated by ſtool, this intention is very well anſwered by the neutral ſalts, as the ſalts of the purging waters, and the *ſal polycreſtum*, with a ſufficient quantity of watery vehicle. Attenuants | Atterbury.

When viſcid humours, occaſioning diſorders of the breaſt, are to be attenuated and expectorated, the intention is moſt effectually anſwered by elecampane and orice roots; and by gum ammoniacum, myrrh, or benjamin, and balſam of Peru; or by regenerated tartar, oxymel of ſquills, a ſolution of crabs eyes in diſtilled vinegar, and the ſyrups of tabacco, and the like.

When the maſs of blood is tainted by thick and tenacious ſordes, and the emunctories are by that means obſtructed, and the humours contaminated by a ſaline ſulphureous and ſcorbutic dyſcracy, the moſt efficacious of the attenuants are the horſe-radiſh, ſcurvy-graſs, water and garden creſſes, muſtard, gum ammoniacum, benjamin, myrrh, the oil of fixed nitre, oil of tartar *per deliquium*, ſolutions of nitre, ſpirit of ſal ammoniac, ſalt of wormwood with lemon juice, and the ſalts of the medicinal waters.

When grumous or coagulated blood, occaſioned by contuſions or blows, is to be attenuated, and again diſſolved, the intention is ſure to be anſwered by the roots of Solomon's ſeal, vinegar, and crabs eyes, the regenerated tartar, and nitre prepared with antimony.

And in caſes where the lymph has acquired a preternatural thickneſs and viſcidity, eſpecially if from a venereal taint, the curative intention is moſt effectually anſwered by gualacum, the acrid tincture of antimony, calomel æthiops mineral, and the like; which, when ſkilfully uſed, are of ſingular efficacy in diſſolving and attenuating the viſcid juices impacted in the glands of the liver.

ATTENUATION, the act of attenuating; that is, of making any fluid thinner, and leſs conſiſtent, than it was before. The word is compounded of *ad* 'to,' and *tenuis* 'thin.' Attenuation is defined more generally by Chauvin, the dividing or ſeparating of the minute parts of any body, which before, by their mutual *nexus* or implication, formed a more continuous maſs. Accordingly, among alchemiſts, we ſometimes find the word uſed for pulverization, or the act of reducing a body into an impalpable powder, by grinding, pounding, or the like.

ATTERBURY (Dr Francis), ſon of Dr Lewis Atterbury, was born at Milton in Buckinghamſhire, 1662; educated at Weſtminſter; and from thence elected to Chriſt-Church in Oxford, where he ſoon diſtinguiſhed himſelf by his fine genius and turn for polite literature. The year he was made M. A. 1687, he exerted himſelf in the controverſy with the Papiſts, vindicated Luther in the ſtrongeſt manner, and ſhowed an uncommon fund of learning, enlivened with great vivacity. In 1690 he married Miſs Oſborn, a diſtant rela-

Atterbury. relation of the Duke of Leeds; a lady of great beauty, but with little or no fortune, who lived at or in the neigbourhood of Oxford.

In Feb. 1690-1, we find him reſolved "to beſtir himſelf in his office in the houſe;" that of cenſor probably, an officer (peculiar to Chriſt-church) who preſides over the claſſical exerciſes; he then alſo held the catechetical lecture founded by Dr Buſby.

About this period it muſt have been that he took orders, and entered into another ſcene, and another ſort of converſation; for in 1691 he was elected lecturer of St Bride's church in London, and preacher at Bridewell chapel. An academic life, indeed, muſt have been irkſome and inſipid to a perſon of his active and aſpiring temper. It was hardly poſſible that a clergyman of his fine genius, improved by ſtudy, with a ſpirit to exert his talents, ſhould remain long unnoticed; and we find that he was ſoon after appointed chaplain to King William and Queen Mary.

The ſhare he took in the controverſy againſt Bentley (about the genuineneſs of the Phalaris Epiſtles) is now very clearly aſcertained. In one of the letters to his noble pupil, dated "Chelſea 1698, (he ſays), the matter had coſt him ſome time and trouble. In laying the deſign of the book, in writing above half of it, in reviewing a good part of the reſt, in tranſcribing the whole, and attending the preſs (he adds), half a year of my life went away."

In 1700, a ſtill larger field of activity opened, in which Atterbury was engaged four years with Dr Wake (afterwards Archbiſhop of Canterbury) and others, concerning the Rights, Powers, and Privileges of Convocations;" in which, however, the truth of the queſton may be ſuppoſed to lie, he diſplayed ſo much learning and ingenuity, as well as zeal for the intereſts of his order, that the Lower Houſe of Convocation returned him their thanks, and the univerſity of Oxford complimented him with the degree of D. D. January 29, 1700, he was inſtalled archdeacon of Totneſs, being promoted to that dignity by Sir Jonathan Trelawny, then Biſhop of Exeter. The ſame year he was engaged, with ſome other learned divines, in reviſing an intended edition of the "Greek Teſtament," with Greek "Scholia," collected chiefly from the fathers, by Mr Archdeacon Gregory. At this period he was popular as preacher at the Rolls Chapel; an office which had been conferred on him by Sir John Trevor, a great diſcerner of abilities, in 1698, when he reſigned Bridewell, which he had obtained in 1693. Upon the acceſſion of Queen Anne in 1702, Dr Atterbury was appointed one of her Majeſty's chaplains in ordinary; and, in October 1704, was advanced to the deanery of Carliſle. About two years after this, he was engaged in a diſpute with Mr Hoadly, concerning the advantages of virtue with regard to the preſent life; occaſioned by his ſermon, preached Auguſt 30, 1706, at the funeral of Mr Thomas Bennet, a bookſeller. In 1707, Sir Jonathan Trelawny, then biſhop of Exeter, appointed him one of the canons reſidentiaries of that church. In 1709, he was engaged in a freſh diſpute with Mr Hoadly, concerning "Paſſive Obedience;" occaſioned by his Latin Sermon, intitled "Concio ad Clerum Londinenſem, habita in Eccleſia S. Elphegi." In 1710, came on the famous trial of Dr Sacheverell, whoſe remarkable ſpeech on that occaſion was generally ſuppoſed to have been drawn up by our author, in conjunction with Dr Smalridge and Dr Freind. The ſame year Dr Atterbury was unanimouſly choſen prolocutor of the Lower Houſe of Convocation, and had the chief management of affairs in that Houſe. May 11, 1711, he was appointed by the Convocation, one of the committee, for comparing Mr Whiſton's doctrines with thoſe of the church of England; and in June following, he had the chief hand in drawing up "A Repreſentation of the Preſent State of Religion." In 1712, Dr Atterbury was made dean of Chriſt-Church, notwithſtanding the ſtrong intereſt and warm applications of ſeveral great men in behalf of his competitor Dr Smalridge. The next year ſaw him at the top of his preferment, as well as of his reputation: for, in the beginning of June 1713, the Queen, at the recommendation of Lord Chancellor Harcourt, advanced him to the biſhopric of Rocheſter, with the deanery of Weſtminſter in commendam; he was confirmed July 4, and conſecrated at Lambeth next day. Atterbury.

At the beginning of the ſucceeding reign, his tide of proſperity began to turn; and he received a ſenſible mortification preſently after the coronation of King George I. when, upon his offering to preſent his Majeſty (with a view, no doubt, of ſtanding better in his favour) with the chair of State and royal canopy, his own perquiſites as dean of Weſtminſter, the offer was rejected, not without ſome evident marks of diſlike to his perſon.

During the rebellion in Scotland, when the Pretender's declaration was diſperſed, the archbiſhop of Canterbury, and the biſhops in and near London, had publiſhed a *Declaration of their Abhorrence of the preſent Rebellion, and an Exhortation to the Clergy and People to be zealous in the diſcharge of their duties to his Majeſty King George:* but the Biſhop of Rocheſter refuſed to ſign it; and engaged biſhop Smalridge in the ſame refuſal, on account of ſome reflections it contained againſt the high-church party. He appeared generally among the proteſtors againſt the meaſures of the miniſtry under the king, and drew up the reaſons of the proteſts with his own hand.

In 1716, we find him adviſing Dean Swift in the management of a refractory chapter. April 26, 1722, he ſuſtained a ſevere trial in the loſs of his lady; by whom he had four children; Francis, who died an infant; Oſborn, ſtudent of Chriſt-Church; Elizabeth, who died September 29, 1716. aged 17; and Mary, who had been then ſeven years married to Mr Morrice.

In this memorable year, on a ſuſpicion of his being concerned in a plot in favour of the Pretender, he was apprehended, Auguſt 24, and committed priſoner to the tower.

Two officers, the under-ſecretary, and a meſſenger, went about two o'clock in the afternoon to the Biſhop's houſe in Weſtminſter, where he then was, with orders to bring him and his papers, before the council. He happened to be in his night-gown when they came in: and being made acquainted with their buſineſs, he deſired time to dreſs himſelf. In the mean time his ſecretary came in; and the officers went to ſearch for his papers; in the ſealing of which the meſſenger brought a paper, which he pretended to have found

Atterbury. found in his close-stool, and desired it might be sealed up with the rest. His Lordship observing it, and believing it to be a forged one of his own, desired the officers not to do it, and to bear witness that the paper was not found with him. Nevertheless they did it; and though they behaved themselves with some respect to him, they suffered the messengers to treat him in a very rough manner, threatening him, if he did not make haste to dress himself, they would carry him away undressed as he was. Upon which he ordered his secretary to see his papers all sealed up, and went himself directly to the Cock-pit, where the council waited for him. The behaviour of the messengers, upon this occasion, seems to have been very unwarrantable, if what the author of "a Letter to the Clergy of the Church of England," &c. tell us be be true, that the persons, directed by order of the King and council, to seize his Lordship and his papers, received a strict command to treat him with great respect and reverence. However this was, when he came before the council, he behaved with a great deal of calmness, and they with much civility towards him. He had liberty to speak for himself as much as he pleased, and they listened to his defence with a great deal of attention; and, what is more unusual, after he was withdrawn, he had twice liberty to re-enter the council-chamber, to make for himself such representations and requests as he thought proper. It is said, that, while he was under examination, he made use of our Saviour's answer to the Jewish council, while he stood before them; "If I tell you, ye will not believe me; and if I also ask you you, ye will not answer me, nor let me go." After three quarters of an hour's stay at the Cock-pit, he was sent to the Tower, privately, in his own coach, without any manner of noise or observation.

This commitment of a bishop, upon a suspicion of high treason, as it was a thing rarely practised since the Reformation, so it occasioned various speculations among the people. Those who were the Bishop's friends, and pretended to the greatest intimacy with him, laid the whole odium of the matter on the ministry. They knew the Bishop so well, they said, his love to our constitution, and attachment to the Protestant succession, his professed abhorence of Popery and settled contempt of the Pretender, and his caution, prudence, and circumspection, to be such as would never allow him to engage in an attempt of subverting the government, so hazardous in itself, and so repugnant to his principles; and therefore they imputed all to the malice and management of a great minister of state or two, who were resolved to remove him, on account of some personal prejudices, as well as the constant molestation he gave them in parliament, and the particular influence and activity he had shown in the late election. The friends to the ministry, on the other hand, were strongly of opinion, that the Bishop was secretly a favourer of the Pretender's cause, and had formerly been tampering with things of that nature, even in the Queen's time, and while his party was excluded from power; but upon their re-admission, had relinquished that pursuit, and his confederates therein, and became a good subject again. They urged, that the influence which the late Duke of Ormond had over him, assisted by his own private ambition and revenge, might prompt him to many things Atterbury. contrary to his declared sentiments, and inconsistent with that cunning and caution which in other cases he was master of. And to obviate the difficulty, arising from the Bishop's aversion to Popery, and the Pretender's bigotry to that religion, they talked of a new-invented scheme of his, not to receive the Pretender, whose principles were not to be changed, but his son only, who was to be educated a Protestant in the church of England, and the bishop to be his guardian, and Lord Protector of the kingdom, during his minority. These, and many more speculations, amused the nation at that time; and men, as usual, judged of things by the measure of their own affections and prejudices.

March 23. 1722-3 a bill was brought into the House commons, for "inflicting certain pains and penalties on Francis Lord bishop of Rochester;" a copy of which was sent to him, with notice that he had liberty of council and solicitors for making his defence. Under these circumstances the Bishop applied, by petition, to the House of Lords, for their direction and advice, as to his conduct in this conjuncture; and April 4, he acquainted the Speaker of the House of Commons, by a letter, that he was determined to give that house no trouble, in relation to the bill depending therein; but should be ready to make his defence against it when it should be argued in another House, of which he had the honour to be a member. On the 9th the bill passed the House of Commons, and was the same day sent up to the House of Lords for their concurrence.

May 6th, being the day appointed by the Lords for the first reading of the bill, Bishop Atterbury was brought to Westminster to make his defence. The counsel for the Bishop were, Sir Constantine Phipps, and William Wynne, Esq. for the King, Mr Reeve, and Mr Wearg. The proceedings continued above a week: and on Saturday May 11th, the Bishop was permitted to plead for himself. This he did in a very eloquent speech; which he feelingly opens by complaining of the uncommon severity he had experienced in the Tower; which was carried to so great a length, that not even his son-in-law Mr Morrice was permitted to speak to him in any nearer mode than standing in an open area, while the Bishop looked out of a two-pair-of-stairs window. In the course of his defence he observes, "Here is a plot of a year or two standing, to subvert the government with an armed force; an invasion from abroad, an insurrection at home: just when ripe for execution, it is discovered; and twelve months after the contrivance of this scheme, no consultation appears, no men corresponding together, no provision made, no arm, no officers provided, not a man in arms; and yet the poor bishop has done all this. What could tempt me to step thus out of my way? Was it ambition, and a desire of climbing into a higher station in the church? There is not a man in my office farther removed from this than I am. Was money my aim? I always despised it too much, considering what occasion I am now like to have for it: for out of a poor bishopric of L. 500 *per annum*, I have laid out no less than L. 1000 towards the repairs of the church and episcopal palace; nor did I take one shilling for dilapidations. The rest of my little income has been

Atterbury. ſpent, as is neceſſary, as I am a biſhop. Was I influenced by any diſlike of the eſtabliſhed religion, and ſecretly inclined towards a church of greater pomp and power? I have, my lords, ever ſince I knew what Popery was, oppoſed it; and the better I knew it, the more I oppoſed it. I began my ſtudy in divinity, when the Popiſh controverſy grew hot, with that immortal book of Tillotſon's, when he undertook the Proteſtant cauſe in general; and as ſuch, I eſteemed him above all. You will pardon me, my lords, if I mention one thing: Thirty years ago, I writ in defence of Martin Luther; and have preached, expreſſed, and wrote to that purpoſe from my infancy; and whatever happens to me, I will ſuffer any thing, and, by God's grace, burn at the ſtake, rather than depart from any material point of the Proteſtant religion as profeſſed in the church of England. Once more: Can I be ſuppoſed to favour arbitrary power? The whole tenor of my life has been otherwiſe: I was always a friend to the liberty of the ſubject; and, to the beſt of my power, conſtantly maintained it. I may have been thought miſtaken in the meaſures I took to ſupport it; but it matters not by what party I was called, ſo my actions are uniform." Afterwards, ſpeaking of the method of proceeding againſt him as unconſtitutional, he ſays: "My ruin is not of that moment to any number of men, to make it worth their while to violate, or even to ſeem to violate, the conſtitution in any degree, which they ought to preſerve againſt any attempts whatſoever. Though I am worthy of no regard, though whatſoever is done to me may for that reaſon be looked upon to be juſt; yet your lordſhips will have ſome regard to your own laſting intereſt and that of poſterity. This is a proceeding with which the conſtitution is unacquainted; which, under the pretence of ſupporting it, will at laſt effectually deſtroy it. For God's ſake, lay aſide theſe extraordinary proceedings; ſet not up theſe new and dangerous precedents. I, for my part, will voluntarily and cheerfully go into perpetual baniſhment, and pleaſe myſelf that I am in ſome meaſure the occaſion of putting a ſtop to ſuch precedents, and doing ſome good to my country: I will live, wherever I am, praying for its proſperity; and do, in the words of Father Paul to the ſtate of Venice, ſay, *Eſto perpetua*. It is not my departing from it I am concerned for. Let me depart, and let my country be fixed upon the immoveable foundation of law and juſtice, and ſtand for ever."—After a ſolemn proteſtation of his innocence, and an appeal to the Searcher of Hearts for the truth of what he had ſaid, he concludes thus: "If, on any account, there ſhall ſtill be thought by your lordſhips to be any ſeeming ſtrength in the proofs againſt me; if, by your Atterbury. lordſhips judgments, ſpringing from unknown motives, I ſhall be thought to be guilty; if, for any reaſons or neceſſity of ſtate, of the wiſdom and juſtice of which I am no competent judge, your lordſhips ſhall proceed to paſs this bill againſt me; I ſhall diſpoſe myſelf quietly and tacitly to ſubmit to what you do; God's will be done: Naked came I out of my mother's womb, and naked ſhall I return; and whether he gives or takes away, bleſſed be the name of the Lord!"

On Monday the 13th he was carried for the laſt time from the Tower to hear the reply of the King's counſel to his defence. Theſe were both men of great knowledge and ſagacity in law, but of different talents in point of eloquence. Their ſpeeches on this occaſion were made public; and they ſeem to have formed their "Replies," deſignedly, in a different way. The former ſticks cloſe to the matter in evidence, and enforces the charge againſt the Biſhop with great ſtrength and perſpicuity: The latter anſwers all his objections, and refutes the arguments brought in his defence, in an eaſy ſoft manner, and with great ſimplicity of reaſoning. Mr. Reeve is wholly employed in facts, in comparing and uniting together circumſtances, in order to corroborate the proofs of the Biſhop's guilt: Mr Wearg is chiefly taken up in ſilencing the complaints of the Biſhop and his counſel, and replying to every thing they advance, in order to invalidate the allegations of his innocence. The one, in ſhort, poſſeſſes the minds of the Lords with ſtrong convictions againſt the Biſhop: The other diſpoſſeſſes them of any favourable impreſſion that might poſſibly be made upon them by the artifice of his defence. And accordingly Mr Reeve is ſtrong, nervous, and enforcing; but Mr Wearg, ſmooth, eaſy, and inſinuating, both in the manner of his expreſſion and the turn of his periods. Mr Wearg pays the higheſt compliments to the Biſhop's eloquence: but, at the ſame time, repreſents it as employed to impoſe upon the reaſon, and miſguide the judgment of his hearers, in proportion as it affected their paſſions; and he endeavours to ſtrip the Biſhop's defence of all its ornaments and colours of rhetoric.

On the 15th the bill was read the third time; and, after a long and warm debate, paſſed on the 16th, by a majority of 83 to 43. On the 27th the King came to the Houſe, and confirmed it by his royal aſſent. June 18. 1723, this eminent Prelate, having the day before taken leave of his friends, who, from the time of paſſing the bill againſt him to the day of his departure, had free acceſs to him in the Tower (B), embarked on board the Aldborough man of war, and

(B) The following anecdote was firſt communicated to the public by the late Dr Maty, on the credit of Lord Cheſterfield: "I went (ſaid Lord Cheſterfield) to Mr Pope, one morning, at Twickenham, and found a large folio Bible, with gilt claſps, lying before him upon his table; and, as I knew his way of thinking upon that book, I aſked him, jocoſely, if he was going to write an anſwer to it? It is a preſent, ſaid he, or rather a legacy, from my old friend the Biſhop of Rocheſter. I went to take my leave of him yeſterday in the Tower, where I ſaw this Bible upon his table. After the firſt compliments, the Biſhop ſaid to me, 'My friend Pope, conſidering your infirmities, and my age and exile, it is not likely that we ſhould ever meet again; and therefore I give you this legacy to remember me by it. Take it home with you; and let me adviſe you to abide by it.'—'Does your Lordſhip abide by it yourſelf?'—'I do.'—'If you do, my Lord, it is but lately. May

Atterbury. landed the Friday following at Calais. When he went on ſhore, having been informed that Lord Bolingbroke, who had after the riſing of the parliament, received the King's pardon, was arrived at the ſame place on his return to England, he ſaid, with an air of pleaſantry, "Then I am exchanged!" and it was, in the opinion of Mr Pope, on the ſame occaſion, "a ſign of the nation's being curſedly afraid of being over-run with too much politeneſs, when it could not regain one great man, but at the expence of another." But the ſeverity of his treatment did not ceaſe even with his baniſhment. The ſame vindictive ſpirit purſued him in foreign climes. No Britiſh ſubject was even permitted to viſit him without the king's ſign manual, which Mr Morice was always obliged to ſolicit, not only for himſelf, but for every one of his family whom he carried abroad with him, for which the fees of office were very high.

When biſhop Atterbury firſt entered upon his baniſhment, Bruſſels was the place deſtined for his reſidence; but, by the arts and inſtigations of the Britiſh miniſters, he was compelled to leave that place, and retire to Paris. There being ſolicited by the friends of the Pretender to enter into their negociations, he changed his abode for Montpelier in 1728; and, after reſiding there about two years, returned to Paris, where he died Feb. 15. 1731-2. The affliction which he ſuſtained by the death of his daughter in 1729, was thought to have haſtened his own diſſolution. The former event he hath himſelf related in a very affecting manner, in a letter to Mr. Pope: "The earneſt deſire of meeting one I dearly loved, called me abruptly to Montpelier; where, after continuing two months under the cruel torture of a ſad and fruitleſs expectation, I was forced at laſt to take a long journey to Touloufe; and even there I had miſſed the perſon I ſought, had ſhe not, with great ſpirit and courage, ventured all night up the Garonne to ſee me, which ſhe above all things deſired to do before ſhe died. By that means ſhe was brought where I was, between ſeven and eight in Atterbury.

I beg to know what new light or arguments have prevailed with you now, to entertain an opinion ſo contrary to that which you entertained of that book all the former part of your life?'—The Biſhop replied, 'We have not time to talk of theſe things; but take home the book; I will abide by it, and I recommend you to do ſo too; and ſo God bleſs you.'

Theſe anecdotes Mr Nichols has inſerted in the "Epiſtolary Correſpondence," Vol. II. p. 79. with the profeſſed view of vindicating Atterbury, in the following words of an ingenius correſpondent:

"Dr Warton hath revived this ſtory, which he juſtly calls an 'uncommon' one, in his laſt 'Eſſay on the Genius and Writings of Pope.' It was indeed very uncommon; and I have my reaſons for thinking it equally groundleſs and invidious. Dr Warton, though he retails the ſtory from 'Maty's Memoirs,' yet candidly acknowledges, that it ought not to be implicitly relied on. That this caution was not unneceſſary, will, I apprehend, be ſufficiently obvious, from the following compariſon between the date of the ſtory itſelf and Mr Pope's letters to the Biſhop.

"According to Lord Cheſterfield's account, this remarkable piece of converſation took place but a few days before the Biſhop went into exile: and it is inſinuated that Mr Pope, till that period, had not even entertained the ſlighteſt ſuſpicion of his friend's reverence for the Bible: Nay, it is aſſerted, that the very recommendation of it from a quarter ſo unexpected, ſtaggered Mr Pope to ſuch a degree, that in a mingled vein of raillery and ſerioufneſs, he was very eager to know the grounds and reaſons of the Biſhop's change of ſentiment.

"Unfortunately for the credit of Lord Cheſterfield and his ſtory, there is a letter on record, that was written nine months before this pretended dialogue took place, in which Mr Pope ſeriouſly acknowledged the Biſhop's piety and generoſity, in intereſting himſelf ſo zealouſly and affectionately in matters which immediately related to his improvement in the knowledge of the holy ſcriptures. The paſſage I refer to is a very remarkable one: and you will find it in a letter, dated July 27. 1722. It appears undeniably from this letter, that the Biſhop had earneſtly recommended to Mr Pope the ſtudy of the Bible; and had ſoftened his zeal with an unuſual urbanity and courteſy, in order to avoid the imputation of ill-breeding, and remove all occaſion of diſguſt from a mind ſo 'trembling alive' as Mr Pope's. I will tranſcribe the paſſage at large. 'I ought firſt to prepare my mind for a better knowledge even of good profane writers, eſpecially the moraliſts, &c. before I can be worthy of taſting the Supreme of books, and Sublime of all writings, in which, as in all the intermediate ones, you may (if your friendſhip and charity towards me continue ſo far) be the beſt guide to, Yours, A. Pope.'

"The laſt letter of Mr Pope to the Biſhop, previous to his going into exile, was written very early in June 1723. It muſt have been about this time that Pope paid his farewel viſit to the Biſhop in the Tower. But whether ſuch a converſation as that which hath been pretended actually took place, may be left to the determination of every man of common ſenſe, after comparing Lord Cheſterfield's anecdote with Mr. Pope's letter.

"There muſt have been a miſtake, or a wilful miſrepreſentation ſomewhere. To determine its origin, or to mark minutely the various degrees of its progreſs, till it iſſued forth into calumny and falſehood, is impoſſible. I have ſimply ſtated matters of fact as they are recorded; and leave it to your readers to ſettle other points not quite ſo obvious and indiſputable, as they may think fit. My motives in this very plain relation aroſe from an honeſt wiſh to remove unmerited obloquy from the dead. I ſhould ſincerely rejoice if the cloud which in other reſpects ſtill ſhades the character of this ingenious Prelate could be removed with equal facility and ſucceſs. I am, dear Sir, your faithful humble ſervant. Samuel Badcock."

Atterbury. in the morning, and lived 20 hours afterwards; which time was not loſt on either ſide, but paſſed in ſuch a manner as gave great ſatisfaction to both, and ſuch as, on her part, every way became her circumſtances and character: For ſhe had her ſenſes to the very laſt gaſp, and exerted them to give me, in thoſe few hours, greater marks of duty and love than ſhe had done in all her lifetime, though ſhe had never been wanting in either. The laſt words ſhe ſaid to me were the kindeſt of all; a reflection on the goodneſs of God, which had allowed us in this manner to meet once more, before we parted for ever. Not many minutes after that, ſhe laid herſelf on her pillow, in a ſleeping poſture.

Placidaque ibi demum morte quievit.

Judge you, Sir, what I felt, and ſtill feel on this occaſion, and ſpare me the trouble of deſcribing it. At my age, under my infirmities, among utter ſtrangers, how ſhall I find out proper reliefs and ſupports? I can have none, but thoſe with which reaſon and religion furniſh me; and thoſe I lay hold on, and graſp as faſt as I can. I hope that he who laid the burden upon me (for wiſe and good purpoſes no doubt) will enable me to bear it in like manner as I have borne others, with ſome degree of fortitude and firmneſs."

How far the Biſhop might have been attached in his inclinations to the Stuart family, to which he might be led by early prejudices of education, and the divided opinions of the times, it is not neceſſary here to enquire: But that he ſhould have been weak enough to engage in a plot ſo inconſiſtent with his ſtation, and ſo clumſily deviſed (to ſay the leaſt of it, and without entering into his ſolemn aſſeveration of innocence), is utterly inconſiſtent with that cunning which his enemies allowed him. The Duke of Wharton, it is well known, was violent againſt him, till convinced by his unanſwerable reaſoning.

It has been ſaid that Atterbury's wiſhes reached to the biſhopric of London, or even to York or Canterbury. But thoſe who were better acquainted with his views, knew that Wincheſter would have been much more deſirable to him than either of the others. And there are thoſe now living, who have been told from reſpectable authority, that that biſhopric was offered to him whenever it ſhould become vacant (and till that event ſhould happen a penſion of L.5000 a-year, beſides an ample proviſion for Mr Morice), if he would ceaſe to give the oppoſition he did to Sir Robert Walpole's adminiſtration, by his ſpeeches and proteſts in the Houſe of Lords. When that offer was rejected by the Biſhop, then the contrivance for his ruin was determined on.

In his ſpeech in the Houſe of Lords, the Biſhop mentions his being "engaged in a correſpondence with two learned men (Biſhop Potter and Dr Wall), on ſettling the times of writing the four goſpels." Part of this correſpondence is ſtill in being, and will ſoon be publiſhed. The ſame ſubject the Biſhop purſued during his exile, having conſulted the learned of all nations, and had nearly brought the whole to a concluſion when he died. Theſe laudable labours are an ample confutation of Biſhop Newton's aſſertion, that Atterbury "wrote little whilſt in exile but a few criticiſms on French authors."

His body was brought over to England, and interred on the 12th of May following in Weſtminſter abbey, in a vault which in the year 1722 had been prepared by his directions. There is no memorial over his grave: nor could there well be any, unleſs his friends would have conſented (which it is moſt probable they refuſed to do) that the words implying him to have died biſhop of Rocheſter ſhould have been omitted on his tomb. Atterbury.

Some time before his death, he publiſhed a vindication of himſelf, Biſhop Smalridge, and Dr Aldrich, from a charge brought againſt them by Mr Oldmixon, of having altered and interpolated the copy of Lord Clarendon's "Hiſtory of the Rebellion." Biſhop Atterbury's "Sermons" are extant in four volumes in octavo: thoſe contained in the two firſt were publiſhed by himſelf, and dedicated to his great patron Sir Jonathan Trelawny biſhop of Wincheſter; thoſe in the two laſt were publiſhed after his death by Dr Thomas Moore his Lordſhip's chaplain. Four admirable "Viſitation Charges" accompany his "Epiſtolary Correſpondence."

As to Biſhop Atterbury's character, however the moral and political part of it may have been differently repreſented by the oppoſite parties, it is univerſally agreed, that he was a man of great learning and uncommon abilities, a fine writer, and a moſt excellent preacher. His learned friend Smalridge, in the ſpeech he made when he preſented him to the Upper Houſe of Convocation, as prolocutor, ſtyles him *Vir in nullo literarum genere hoſpes, in pleriſque artibus et ſtudiis diu et feliciter exercitatus, in maxime perfectis literarum diſciplinis perfectiſſimus.* In his controverſial writings, he was ſometimes too ſevere upon his adverſary, and dealt rather too much in ſatire and invective: but this his panegyriſt imputes more to the natural fervour of his wit than to any bitterneſs of temper or prepenſe malice. In his ſermons, however, he is not only every way unexceptionable, but highly to be commended. The truth is, his talent as a preacher was ſo excellent and remarkable, that it may not improperly be ſaid, that he owed his preferment to the pulpit; nor any hard matter to trace him, through his writings, to his ſeveral promotions in the church. We ſhall conclude Biſhop Atterbury's character, as a preacher, with the encomium beſtowed on him by the author of "the Tatler;" who, having obſerved that the Engliſh clergy too much neglect the art of ſpeaking, makes a particular exception with regard to our prelate; who, ſays he, "has ſo particular a regard to his congregation, that he commits to his memory what he has to ſay to them; and has ſo ſoft and graceful a behaviour, that it muſt attract your attention. His perſon (continues this author), it is to be confeſſed, is no ſmall recommendation; but he is to be highly commended for not loſing that advantage, and adding to propriety of ſpeech (which might paſs the criticiſm of Longinus) an action which would have been approved by Demoſthenes. He has a peculiar force in his way, and has many of his audience, who could not be intelligent hearers of his diſcourſe were there no explanation as well as grace in his action. This art of his is uſed with the moſt exact and honeſt ſkill. He never attempts your paſſions, till he has convinced your reaſon. All the objections which you can form are laid open and diſperſed before he uſes the leaſt ve-

Atteſtation 1 Attica.

hemence in his ſermon; but when he thinks he has your head, he very ſoon wins your heart, and never pretends to ſhow the beauty of holineſs, till he has convinced you of the truth of it."—In his letters to Pope, &c. Biſhop Atterbury appears in a pleaſing light, both as a writer and as a man. In eaſe and elegance they are ſuperior to thoſe of Pope, which are more ſtudied. There are in them ſeveral beautiful references to the claſſics. The Biſhop excelled in his alluſions to ſacred as well as profane authors.

ATTESTATION, the act of affirming or witneſſing the truth of ſomething, more eſpecially in writing.

ATTIC, any thing relating to Attica, or to the city of Athens: thus Attic ſalt, in philology, is a delicate poignant ſort of wit and humour peculiar to the Athenian writers; Attic witneſs, a witneſs incapable of corruption, &c.

Attic Order. See ARCHITECTURE.

Attic Baſe, a peculiar kind of baſe uſed by the ancient architects in the Ionic order; and by Palladio, and ſome others, in the Doric.

Attic Story, in architecture; a ſtory in the upper part of a houſe, where the windows are uſually ſquare.

1 Boundaries extent, &c.

ATTICA, an ancient kingdom of Greece, ſituated along the north coaſt of the gulph of Saron, bounded on the weſt by Megara, mount Cithæron, and part of Bœotia; on the north by the gulph of Euripus, now *Stretto di negro ponte*, and the reſt of Bœotia; and on the eaſt by the Europius. It extended in length from north-weſt to ſouth-eaſt about 60 miles; its breadth from north to ſouth was 56, decreaſing as it approached the ſea.

The ſoil of this country was naturally barren and craggy, though by the induſtry of its inhabitants it produced all the neceſſaries of life. On this account Attica was leſs expoſed to invaſions than other more fertile countries; and hence it preſerved its ancient inhabitants beyond all the other kingdoms in its neighbourhood; ſo that they were reputed to be the ſpontaneous productions of the ſoil; and as a badge of this, Thucydides tells us, they wore golden graſshoppers in their hair.

2 Inhabitants thought to be produced from the ſoil.

3 Cities.

The chief cities in the kingdom of Attica were Athens the capital; next to it Eleuſis, ſituated on the ſame gulph, near the coaſts of Megara; and next to that Rhamnus, famed for the temple of Amphiaraus and the ſtatue of the goddeſs Nemeſis.

4 Cecrops the firſt king.

The firſt king of this country, of whom we have any diſtinct account, was Cecrops. Others indeed are ſaid to have reigned before him, particularly one Actæus, whoſe daughter Cecrops married, and in her right laid the foundation of his new monarchy. Cecrops is ſaid to have been the firſt who deified Jupiter, ſet up altars and idols, and inſtituted marriage among the Greeks. He is likewiſe affirmed to have taught his ſubjects navigation; and for the better adminiſtration of juſtice, and promoting intercourſe among them, to have divided them into the firſt four tribes, called *Cecropis*, *Autochton*, *Actea*, and *Paralia*; and he is alſo by ſome ſaid to be the founder of the Areopagus. From this monarch the Athenians affected to call themſelves *Cecropidæ* till the reign of Erectheus their ſixth king, after whom they took the name of *Erectbydæ*.

Cecrops dying after the reign of 50 years, left three daughters; by marrying one of which, probably, Cranaus a wealthy citizen aſcended the throne. He enjoyed his crown peaceably for ten years; till, having married one of his daughters, named *Attis*, to Amphictyon the ſon of Deucalion, he was by him dethroned, and forced to lead a private life to the laſt. From this daughter, the country, which before had been called *Actea*, took the name of *Attica*.

Attica. 5 Cranaus. 6 Whence the country was called *Attica*.

After a reign of 10 or 12 years, Amphictyon was himſelf depoſed by Ericthonius, ſaid to be the ſon of Vulcan and Tethys. Being lame of both his feet, he is ſaid to have invented coaches, or, as others will have it, inſtituted horſe and chariot races in honour of Minerva. He is alſo reported to have been the firſt who ſtamped ſilver coin. He reigned 50 years, and was ſucceeded by his ſon Pandion the father of Progne and Philomela; whoſe hard fate, ſo famous among the poets, is ſuppoſed to have broke his heart, after a reign of about 40 years. In his time Triptolemus taught the Athenians agriculture, which he had learned from Ceres.

7 Ericthonius. 8 Pandion.

Pandion was ſucceeded by his ſon Erectheus, who being reckoned the moſt powerful prince of his time, Boreas king of Thrace demanded his daughter Orithia in marriage, and on being refuſed carried her off by force. After a reign of 50 years, Erectheus being killed in a battle with the Eleuſians, was ſucceeded by his ſon Cecrops II. who is generally allowed to have been the firſt who gathered the people into towns; they having till then lived in houſes and cottages ſcattered here and there, without order or regular diſtance. After a reign of 40 years he was driven out by his brethren Metion and Pandorus, who forced him to fly into Ægialea, where he died.

9 Erectheus. 10 Cecrops II.

Cecrops II. was ſucceeded by his ſon Pandion II. and he was likewiſe driven out by Metion, who aſſumed the government. Pandion in the mean time fled into Megara, where he married Pelia the daughter of Pylas king of that place, and was appointed ſucceſſor to the kingdom. Here he had four ſons, who returning to Athens, whether with or without their father is uncertain, expelled the ſons of Metion, and after the deceaſe of Pandion their father, divided the government among themſelves; notwithſtanding which the royal dignity did in effect remain with Ægeus the eldeſt.

11 Pandion II. 12 Ægeus.

Ægeus, when he aſcended the throne, finding himſelf deſpiſed by his ſubjects becauſe he had no ſons, and ſometimes inſulted by his brother Pallas, who had no leſs than fifty, conſulted the oracle of Apollo at Delphi. Receiving here, as was commonly the caſe, an anſwer which could not be underſtood without a commentator, he applied to Pittheus king of Troezen, famous for his ſkill in expounding oracles. This prince eaſily prevailed with him to lie with his daughter Æthra, who proved with child; and as none but theſe three were privy to the ſecret, Ægeus, before his return to Athens, hid a ſword and a pair of ſhoes under a ſtone, leaving orders with the princeſs, that if the child proved a boy, ſhe ſhould ſend him to Athens with theſe tokens as ſoon as he was able to lift up that ſtone. He charged her moreover to uſe all imaginable ſecrecy, leſt the ſons of his brother Pallas ſhould way-lay and murder him.

13 Theſeus born.

Æthra being delivered of a ſon, Pittheus gave out that Neptune was the father of it. This child was named

Attica.

named *Theſeus*, and proved one of the moſt famous heroes of antiquity. Being arrived at the age of 16, his mother brought him to the ſtone abovementioned; and he having lifted it with eaſe, was deſired to take up the ſword and ſhoes and prepare himſelf to go to his father. He was adviſed to go by ſea rather than by land, as, ever ſince the departure of Hercules, the roads had been exceedingly infeſted by banditti. Theſeus, however, who had already begun to diſcover marks of uncommon ſtrength and courage, no ſooner heard the name of Hercules mentioned, than he became deſirous of imitating ſo great a pattern; and after performing a number of glorious exploits, for which ſee the article THESEUS, he arrived ſafe at his father's capital.

14 Is made known to his father.

The great atchievements of our young hero procured him a welcome reception at the court of Ægeus, though his birth was unknown to all except Medea, to whom the king had lately been married. This queen being a ſorcereſs, it is not to be ſuppoſed any thing could be concealed from her: ſhe therefore, by her diabolical penetration, quickly found out that Theſeus was the king's ſon; after which ſhe became ſo jealous of him on account of his valour, that ſhe perſuaded her old huſband to invite the young ſtranger to a banquet, and poiſon him in a glaſs of wine. The poiſon was accordingly prepared, and Theſeus invited; but the prince ſuddenly drawing his ſword, it was immediately recognized by Ægeus to be the ſame he had formerly buried below the ſtone. Upon this he ſtepped forward to Theſeus, throwing down the poiſoned draught in his way; and, embracing him with much tenderneſs, owned him for his ſon before all the court.

At this time the king of Athens had great occaſion for ſuch a champion as Theſeus. The ſons of Pallas, who had all along behaved with great inſolence, upon Theſeus being diſcovered to be the king's ſon, and heir apparent to the crown, broke out in open rebellion. They were ſoon diſcomfited; but Ægeus and the whole country of Attica were ſtill in great diſtreſs on the following account. Some years before, Androgeus, the ſon of Minos king of Crete, came to Athens to be preſent at one of their feaſts. During this viſit he contracted ſuch an intimacy with the fifty ſons of Pallas, that Ægeus fearing ſome fatal conſequences, cauſed him to be privately murdered. According to others, Androgeus having undertaken to encounter the Marathonian bull, was killed by it. Be this as it will, Minos having received news of his ſon's death, imputed it to the people of Attica; and therefore, after ſeveral unſucceſsful attempts to revenge his own quarrel, prayed to the gods to do it for him. The Athenians, in conſequence of this prayer, were viſited with earthquakes, famine, and peſtilence; on account of which they applied to the oracle. Here they were informed, that no relief was to be had till they were reconciled to the Cretan king. Minos reſolving to make them pay dear for their deliverance, impoſed upon them a tribute of ſeven young men and as many virgins, whom he condemned to be devoured by the Minotaur, a monſter feigned by the poets to have been half man and half bull. This bloody tribute had been twice paid, and Minos had already ſent his meſſengers the third time, when Theſeus willingly offered himſelf to be one of the unhappy victims; and embarking with them in one ſhip, he gave the pilot two ſails, the one black to ſail with, and the other white to be hoiſted up at his return in caſe he came off victorious. Our hero had all the ſucceſs he could wiſh: he killed the Minotaur, prevailed with Minos to remit the tribute, and his daughter Ariadne to run away with him; but her he left with child in the iſle of Naxos. Unfortunately, however, for Ægeus, the joy of Theſeus and his company was ſo great, that at their return they forgot to hoiſt the white flag in token of their victory: upon which the old king, taking for granted that his ſon was killed, threw himſelf into the ſea, which ever ſince has from him been called the *Ægean Sea*.

Attica.

15 He kills the Minotaur.

16 Death of Ægeus.

17 Theſeus king of Attica.

Theſeus being thus left in poſſeſſion of the kingdom of Attica, began immediately to think of indulging his warlike genius, and rendering the civil affairs of his kingdom as little troubleſome as poſſible. To accompliſh this purpoſe, he began with gathering moſt of the people of Attica into the old and new town, which he incorporated into one city. After this he diveſted himſelf of all his regal power, except the title of king, the command of the army, and the guardianſhip of the laws. The reſt he committed to proper magiſtrates choſen out of three different orders of the people, whom he divided into nobles, huſbandmen, and artificers. The firſt he inveſted with the power of interpreting and executing the laws, and regulating whatever related to religion. The other two choſe their inferior magiſtrates from among themſelves, to take care of whatever related to their ſeparate orders: ſo that the kingdom was in ſome meaſure reduced to a commonwealth, in which the king had the greateſt poſt, the nobles were next to him in honour and authority, the huſbandmen had the greateſt profit, and the artiſts exceeded them in number. He likewiſe aboliſhed all their diſtinct courts of judicature, and built one common council-hall called *Prytaneum*, which ſtood for many ages afterwards.

18 New models the government.

Having thus new-modelled the government, his next care was to join to his dominions the kingdom of Megara, in right of his grandfather Pandion II. who had married the daughter of Pylas, as abovementioned. On this occaſion he erected the famous pillar in the iſthmus, which ſhowed the limits of the two countries that met there. On the one ſide of this pillar was inſcribed, "This is not Peloponneſus, but Ionia;" and on the other, "This is Peloponneſus, not Ionia." After this he undertook an expedition againſt the Amazons, whom he overcame, took their queen Hippolita, and afterwards married her. Soon after this, Theſeus contracted an intimacy with Perithous the ſon of Ixion; and being invited to his nuptials, aſſiſted him in killing a number of Centaurs, or rather Theſſalian horſemen (who in their cups had offered violence to their female gueſts), and drove the reſt out of the country. Our two aſſociates then proceeded to Sparta, where Theſeus fell in love with the famed Helena, at that time not above nine years old, while he himſelf was upwards of fifty. Her they carried off: and of the rape there are various accounts; but the following one, which is given by Plutarch, is generally allowed to be the moſt authentic.

19 Defeats the Amazons, kills the Centaurs, and carries off Helena.

According to that hiſtorian, they ſtole this beauty, the greateſt in the world at this time, out of the temple of Diana Ortia, where Helena happened to be dancing. They were purſued as far as Tegea, but made their

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their eſcape out of Peloponneſus; and thinking themſelves now ſecure of their prey, they agreed to caſt lots for her, upon condition that he to whoſe lot ſhe fell ſhould aſſiſt the other in procuring ſome celebrated beauty. Fortune having declared for Theſeus, he aſſiſted his companions in the like attempt upon Proſerpina daughter of Aidonius king of the Molloſſi in Epirus; who, being the next beauty to Helena, was guarded by the dog Cerberus, which had three heads, and was conſequently a very formidable enemy. Her father, however, underſtanding that they deſigned to ſteal away his daughter, threw Perithous to be torn in

20 Impriſoned by the king of Epirus.

pieces by Cerberus, and put Theſeus in priſon, from whence he was afterwards relieved at the interceſſion of Hercules.

After this misfortune, Theſeus at length returned to Athens, but found himſelf very coolly received by his ſubjects. Mneſtheus, the ſon of Peteus, and great-grandſon of Erectheus, had made uſe of the king's abſence to ingratiate himſelf with the people; and upon the commencement of a war with Caſtor and Pollux, the two brothers of Helena, he perſuaded the people of

21 Driven out of Athens.

Athens to open their gates to the two brothers. Upon this, Theſeus was under the neceſſity of conveying away himſelf and family with all poſſible privacy. This he luckily accompliſhed; and deſigned to have ſailed to Crete, to have obtained aſſiſtance from Deucalion ſon of Minos, and now brother-in-law to Theſeus himſelf, he having lately married Phædra ſiſter to Deucalion. Unfortunately, however, our hero was ſhipwrecked on

22 His death.

the iſland of Scyros. Here he he was at firſt kindly received by Lycomedes the king of that iſland, but was ſoon after killed by a fall from a high rock, over which ſome ſay he was puſhed by Lycomedes himſelf, who had been prevailed upon to deſtroy Theſeus in that manner by Mneſtheus, that he might with the more ſecurity enjoy the kingdom of Athens.

23 Mneſtheus, Demophon, &c.

Mneſtheus reigned 24 years, but loſt his life at the ſiege of Troy; and was ſucceeded by Demophon one of the ſons of Theſeus by Phædra, who was likewiſe at the ſiege of Troy, but had the good fortune to return in ſafety. In his reign was erected the famous court of the Ephetæ; conſiſting originally of 50 Athenians and as many Argives, for trying of wilful murders. By this court the king himſelf afterwards ſubmitted to be tried for having accidentally killed one of his ſubjects. He reigned 33 years, and was ſucceeded by his ſon, according to ſome, or according to others his brother, Oxyntes, who reigned 12 years. Oxyntes was ſucceeded by his ſon Aphydas, who was murdered by Thymætes the baſtard ſon of Oxyntes.

24 Thymætes depoſed.

This king diſcovered many baſe qualities unworthy of his dignity; and at laſt was depoſed by his ſubjects on the following occaſion. Xanthus king of Bœotia had a conteſt with the Athenians about one of their frontier towns. He offered to decide the matter by ſingle combat with the king; but this was declined by Thymætes. It happened, that at that time one Melanthus a Meſſenian, who had been driven out of his country by the Heraclidæ, was come to Athens; who accepted the king of Bœotia's challenge. At the firſt onſet, Melanthus aſked his adverſary, why he had, contrary to the articles, brought a ſecond into the field with him? and as Xanthus immediately looked about to ſee who was behind him, Melanthus run him through with his lance. The victory, though it did little honour to him who gained it, was ſo agreeable to the Athenians, that they depoſed their cowardly king Thymætas, after he had reigned 8 years; and appointed Melanthus in his ſtead, who after a reign of 37 years left the kingdom to his ſon Codrus.

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25 Melanthus

26 Codrus the laſt king ſacrifices himſelf for his country

This prince reigned about 21 years; during which time the Dores and Heraclidæ had regained all Peloponneſus, and were upon the point of entering into Attica. Codrus, being informed that the oracle had promiſed them victory provided they did not kill the king of the Athenians, came immediately to a reſolution of dying for his country. Diſguiſing himſelf, therefore, like a peaſant, he went into the enemy's camp, and, quarrelling with ſome of the ſoldiers, was killed by them. On the morrow, the Athenians knowing what was done, ſent to demand the body of their king; at which the invaders were ſo terrified, that they decamped without ſtriking a blow.

27 Republican government introduced.

Upon the death of Codrus, a diſpute which happened among his ſons concerning the ſucceſſion, furniſhed the Athenians with a pretence for ridding themſelves of their kings altogether, and changing the monarchial form of government into a republican one. It was improbable, they ſaid, that they ſhould ever have ſo good a king as Codrus; and to prevent their having a worſe, they reſolved to have no king but Jupiter. That they might not, however, ſeem ungrateful to the family of Codrus, they made his ſon Medon their ſupreme magiſtrate, with the title of *archon*. They afterwards rendered that office decennial, but continued it ſtill in the family of Codrus. The extinction of the Medontidæ at laſt left them without reſtraint; upon which they not only made this office annual, but created nine archons. By the latter invention they provided againſt the too great power of a ſingle perſon, as by the former they took away all apprehenſion of the archons having time to eſtabliſh themſelves, ſo as to change the conſtitution. In a word, they now attained what they had long ſought, viz. the making the ſupreme magiſtrates dependent on the people.

We have a liſt of theſe archons for upwards of 600 years, beginning with Creon, who lived about 684 years before Chriſt, to Herodes, who lived only 60 years before that time. The firſt archon of whom we

28 Draco legiſlator of Athens.

hear any thing worth notice, is named *Draco*. He reigned in the ſecond, or, as others ſay, in the laſt year of the 39th Olympiad, when, it is ſuppoſed, he publiſhed his laws: but though his name is very frequently mentioned in hiſtory, yet no connected account can be found either of him or his inſtitutions; only, in general, his laws were exceedingly ſevere, inflicting death for the ſmalleſt faults; which gave occaſion to one Demades an orator to obſerve, that the laws of Draco were written with blood, and not with ink. For this extraordinary ſeverity he gave no other reaſon, than that ſmall faults ſeemed to him to be worthy of death, and he could find no higher puniſhment for the greateſt. He was far advanced in years when he gave laws to Athens; and to give his inſtitutions the greater weight, he would not ſuffer them to be called *nomoi*, or laws, but *theſmoi*, or ſanctions proceeding from more than human wiſdom. The extreme ſeverity of theſe laws, however, ſoon made the Athenians weary both of them and the author of them; upon which Draco was

29 Expelled the city.

obliged

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obliged to retire to Ægina. Here he was received with the higheſt honours: but the favour of the inhabitants of this place proved more fatal to him than the hatred of the Athenians; for coming one day into the theatre, the audience, to ſhow their regard, threw, as the cuſtom then was, their cloaks upon him; and the multitude of theſe being very great, they ſtifled the old man, who was too weak to diſengage himſelf from their load.

30 His death.

After the expulſion of Draco, nothing remarkable happened at Athens till the year before Chriſt 606, when we find the republic engaged in a war with the Mitylenians about the city Sigæum, ſituated near the mouth of the river Scamander. The Athenian army was commanded by Phrynon, a perſon equally remarkable for the comelineſs of his perſon and the generoſity of his mind. The Mitylenians were commanded by Pittacus, one of the celebrated ſages of Greece. As the commanders looked upon the honour of their reſpective countries to be concerned, they exerted themſelves to the utmoſt. At laſt they met in ſingle combat: wherein Phrynon depended on his valour only; but Pittacus concealed behind his ſhield a net, wherewith he ſuddenly entangled his antagoniſt, and eaſily ſlew him. This, however, not putting an end to the war, Periander tyrant of Corinth interpoſed; and both parties having ſubmitted to his arbiration, he decreed that Sigæum ſhould belong to the Athenians.

31 Mitylenian war.

About ſeven years after this war, a conſpiracy was formed by Cylon ſon-in-law to Theagenes tyrant of Megara, who, having by his affable behaviour procured many friends, formed a deſign of ſeizing the ſovereignty of Athens. Having conſulted the oracle as to the moſt proper time, he was directed to make the attempt when the citizens of Athens were employed in celebrating the higheſt feaſt to Jupiter. When many of the citizens therefore were gone to the Olympic games, Cylon and his aſſociates made themſelves maſters of the citadel. Here they were inſtantly beſieged by Megacles at that time archon, and ſoon reduced to great diſtreſs for want of water. The chief together with his brother found means to make their eſcape, but the meaner ſort were left to ſhift for themſelves. In this extremity they fled to the temple of Minerva; from whence Megacles with much ado prevailed upon them to come down and ſubmit themſelves to the mercy of their country. Having at laſt aſſented to this, they tied a cord to the image of the goddeſs, and carried the clue with them, to demonſtrate, that though they were out of the temple they were ſtill under Minerva's protection. Unfortunately for them, however, as they paſſed the temple of the furies, the line ſnapt of itſelf; which Megacles conſtruing into a renunciation by the goddeſs, cauſed his men fall upon them and diſpatch as many as they could find. Such as were without the temple were immediately maſſacred, and thoſe who fled thither again were murdered in their ſanctuary. In ſhort, none eſcaped but ſuch as bribed the wives of the officers of juſtice. This carnage, however, did not put an end to the ſedition. The remains of Cylon's faction created great diſturbances, by inſinuating that the violation of Minerva's ſanctuary had drawn down the anger of the gods; and theſe diſcourſes had ſuch an effect, that Megacles and his officers were ſtyled *execrable*, and held to be perſons under the diſpleaſure of heaven.

32 Cylon's conſpiracy.

33 Conſpirators maſſacred by Megacles.

34 Who is execrated by the people.

During the time of this confuſion, the Megarenſians attacked Niſea, which they took, as well as Salamis; and ſo completely routed the Athenians in every attempt to recover the latter, that a law was at laſt paſſed by which it ſhould be capital for any one to propoſe the recovery of Salamis. About the ſame time the city was diſturbed by reports of frightful appearances, and filled with ſuperſtitious fears; the oracle at Delphi was therefore conſulted, and an anſwer returned that the city behoved to be expiated. Upon this, Epimenides the Pheſtian was ſent for from Crete, to perform the neceſſary ceremonies, he being reputed an holy man, and one that was deeply ſkilled in all the myſteries of religion. His expiation conſiſted in taking ſome black, and ſome white ſheep, turning them all looſe, and directing ſome perſons to follow them to thoſe places where they couched, and there to ſacrifice them to the local deity. He cauſed alſo many temples and chapels to be erected, two of which have been particularly noted, viz. the chapel of *Contumely* and that of *Impudence*. This man is ſaid to have looked wiſtfully on the port of Munychia for a long time, and then to have ſpoke as follows to thoſe that were near him. "How blind is man to future things? for did the Athenians know what miſchief will one day be derived to them from this place, they would eat it with their teeth." This prediction was thought to be accompliſhed 270 years after, when Antipater conſtrained the Athenians to admit a Macedonian garriſon into that place.

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35 Unſucceſsful war with Megara.

36 Epimenides's expiation and prophecy.

About 597 years before Chriſt, Solon the famed Athenian legiſlator began to ſhow himſelf to his countrymen. He is ſaid to have been lineally deſcended from Codrus; but left by his father in circumſtances rather neceſſitous, which obliged him to apply to merchandize; it is plain, however, both from his words and writings, that he was a diſintereſted patriot. The ſhameful decree, that none under pain of death ſhould propoſe the recovery of Salamis, grieved him ſo much, that having compoſed an elegy of 100 verſes, ſuch as he thought would be moſt proper to inflame the minds of the people, he ran into the market-place as if he had been mad, with his night-cap on his head, repeating his elegy. A crowd being gathered round the pretended madman, his kinſman Piſiſtratus mingled among the reſt, and obſerving the people moved with Solon's words, he alſo ſeconded him with all the eloquence he was maſter of, and between them they prevailed ſo far as to have the law repealed, and a war was immediately commenced againſt the people of Megara. Who was commander in this expedition is not certain; but the city was recovered, according to the moſt general account, by the following ſtratagem. Solon coming with Piſiſtratus to Colias, and finding there the women buſy in celebrating, according to cuſtom, the feaſt of Ceres, ſent a confident of his to Salamis, who pretended to be no friend to the people of Attica, telling the inhabitants of Salamis, that if they had a mind to ſeize the faireſt of the Athenian ladies, they might now do it by paſſing over to Colias. The Megarenſians giving eaſy credit to what the man ſaid, immediately fitted out a ſhip; which Solon perceiving from the oppoſite ſhore, diſmiſſed the women, and having dreſſed a number of beardleſs youths in female habits, under which

37 Solon the wiſe legiſlator.

38 Salamis recovered by his means.

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which they concealed every one a dagger, he ſent them to the ſea-ſide to dance and divert themſelves as the women are wont to do. When thoſe who came from Salamis ſaw theſe young perſons ſkipping up and down, they ſtrove who ſhould be firſt on ſhore; but were every one of them killed, and their veſſel ſeized; aboard which the Athenians embarking, ſailed immediately to Salamis and took it.

39 Cirrha likewiſe reduced by Solon's wiſdom.

On the return of Solon to Athens, he was greatly honoured by the people, to whom another occaſion of admiring his wiſdom was quickly afforded. The inhabitants of Cirrha, a town ſituated in the bay of Corinth, after having by repeated incurſions waſted the territory of Delphi, at laſt beſieged the capital itſelf, with a view of making themſelves maſters of the treaſures contained in the temple of Apollo. Advice of this intended ſacrilege being ſent to the Amphictyons, who were the ſtates-general of Greece, Solon adviſed that the matter ſhould be univerſally reſented, and that all the ſtates ſhould join in puniſhing the Cirrhæans, and ſaving the Delphic oracle. This advice was complied with, and a general war againſt Cirrha declared. Clyſthenes, tyrant of Sicyon, commanded in chief, and Alcmæon was general of the Athenian quota. Solon went as aſſiſtant or counſellor to Clyſthenes, and by following his advice the war was conducted to a proſperous iſſue. For when the Greek army had beſieged Cirrha for ſome time without any appearance of ſucceſs, the oracle at Delphi was conſulted, from whence the following anſwer was returned:

"In vain you hope to take the place before
"The ſea's blue waves roll o'er the hallow'd ſhore."

This anſwer ſtruck the whole army with ſurpriſe, till Solon adviſed Clyſthenes to conſecrate ſolemnly the whole territory of Cirrha to the Delphic Apollo; ſo as that was a maritime country, the ſea muſt then waſh the ſacred coaſt. According to Pauſanius, the city was reduced by the following ſtratagem, likewiſe invented by Solon. He cauſed the river Pliſtus, which run through Cirrha, to be turned into another channel, hoping thereby to have diſtreſſed the inhabitants for want of water: but finding they had many wells within the city, and were not to be reduced by that means, he cauſed a vaſt quantity of roots of hellebore to be thrown into the river, which was then ſuffered to return into its former bed. The inhabitants, overjoyed at the ſight of running water, came in troops to drink of it; whereupon an epidemic flux enſued, and the citizens being no longer able to defend the walls, the town was eaſily taken.

40 Athens in great confuſion.

On the return of Solon to Athens he found things again in the utmoſt confuſion. The remnant of Cylon's faction gave out, that all ſorts of misfortunes had befallen the republic on account of the impiety of Megacles and his followers; which clamour was heightened by the retaking of Salamis about this time by the Megarenſians. Solon interpoſed, and perſuaded thoſe who were ſtyled *execrable* to abide a trial, and 300 perſons were choſen to judge them. The event was, that

41 Megacle's party baniſhed.

300 of Megacle's party who were alive were ſent into perpetual baniſhment, and the bones of ſuch as were dead were dug up and ſent without the limits of their country.

Though this deciſion reſtored the public quiet for the preſent, it was not long before the people were divided into three factions, contending about the proper form of government. Theſe were called the *Diacrii*, *Pediæi*, and *Parali*: the firſt of theſe were the inhabitants of the hilly country, who declared poſitively for democracy; the ſecond, dwelling in the lower parts, and who were far more opulent than the former, declared for an oligarchy, as ſuppoſing the government would fall moſtly into their hands; the third party, who lived on the ſea-coaſt, were people of moderate principles, and therefore were for a mixed government. Beſides the diſturbances raiſed on this account, others were occaſioned by the rich oppreſſing the poor. According to Plutarch, the poor being indebted to the rich, either tilled their grounds and paid them the ſixth part of the produce, or engaged their bodies for their debts, ſo that many were made ſlaves at home, and many ſold into other countries; nay, ſome were obliged to ſell their children to pay their debts, and others in deſpair quitted Attica altogether. The greateſt part, however, were for throwing off the yoke, and began to look about for a leader, openly declaring that they intended to change the form of government, and make a repartition of lands. In this extremity, the eyes of all the citizens were caſt upon Solon. The moſt prudent were for offering him the ſovereignty; but he perceiving their intentions, behaved in ſuch a manner as to cheat both parties, and ſhewed a ſpirit of patriotiſm perhaps never equalled. He refuſed the ſovereignty as far as it might have benefited himſelf; and yet took upon himſelf all the care and trouble of a prince, for the ſake of his people.

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42 Three factions ſtart up.

43 Solon choſen archon.

He was choſen archon without having recourſe to lots, and after his election diſappointed the hopes of both parties. It was Solon's fundamental maxim, That thoſe laws will be beſt obſerved which power and juſtice equally ſupport. Wherever, therefore, he found the old conſtitution conſonant to juſtice in any tolerable degree, he refuſed to make any alteration at all, and was at extraordinary pains to ſhow the reaſon of the changes he did make. In ſhort, being a perfect judge of human nature, he ſought to rule only by ſhowing his ſubjects that it was their intereſt to obey, and not by forcing upon them what he himſelf eſteemed beſt. Therefore, to a perſon who aſked whether he had given the Athenians the beſt laws in his power, he replied, "I have eſtabliſhed the beſt they could receive."

44 Settles all diſorders.

As to the main cauſe of ſedition, viz. the oppreſſed ſtate of the meaner ſort Solon removed it by a contrivance which he called *ſiſachthia*, i. e. *diſcharge*; but what this was, authors are not agreed upon. Some ſay that he releaſed all debts then in being, and prohibited the taking any man's perſon for payment of a debt for the future. According to others the poor were eaſed, not by cancelling the debts, but by lowering the intereſt, and increaſing the value of money; a mina, which before was made equal to 73 drachms only, being by him made equal to 100; which was of great advantage to the debtor, and did the creditor no hurt. It is, however, moſt probable that the ſiſachthia was a general remittance of all debts whatever, otherwiſe Solon could not have boaſted in his verſes that

he

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he had removed ſo many marks of mortgages (B) as were every where frequent; that he had freed from apprehenſion ſuch as were driven to deſpair, &c.

45 Infamous behaviour of his three friends.

But in the midſt of all Solon's glory, an accident befel him, which, for a time, hurt his reputation, and had almoſt entirely ruined his ſchemes. He had conſulted Conon, Clinias, and Hipponicus, his three friends, on an oration prepared with a view to engage the people's conſent to the diſcharge; and theſe three men, thus knowing there was to be a general diſcharge of debts, baſely took the opportunity of borrowing vaſt ſums before the law was promulgated, in conſequence of which they were never obliged to return them.

This was thought at firſt to have been done with Solon's conſent, and that he had ſhared in the money; but this aſperſion was quickly wiped off when it appeared that the lawgiver himſelf was a very conſiderable loſer by his own law. His friends, however, could never recover their credit, but were ever afterwards ſtigmatized with the opprobrious appellation of *chreocopidæ*, or *debt-ſinkers*.

46 Solon blamed at firſt, but afterwards applauded and choſen legiſlator.

The Athenians were as little pleaſed with Solon's management as with their former condition; the rich thinking he had done too much in cancelling the money-debts due to them, and the poor that he had done too little, becauſe he had not divided the lands of Attica equally. In a ſhort time, however, they acquieſced in the new inſtitutions, and gave a more public token of their repentance than they had before ſhown of their diſpleaſure, inſtituting a ſolemn ſacrifice under the name of *Siſacthia*, at the ſame time that Solon was unanimouſly elected legiſlator of Athens, with full power to make laws, and alter or new model the conſtitution as he thought fit.

47 Compiles a new body of laws.

Solon being now inveſted with unlimited authority, ſet about the arduous taſk of compiling new laws for the turbulent people of Attica; which having at laſt completed in the beſt manner he was able, or in the beſt manner the nature of the people would admit, he procured them to be ratified for 100 years. Such as related to private actions were preſerved on parallelograms of wood, with caſes which reached from the ground, and turned about upon a pin like a wheel. Theſe were thence called *Axones*; and were placed firſt in the citadel, and afterwards in the prytaneum, that all the ſubjects might have acceſs to them when they pleaſed. Such as concerned public inſtitutions and ſacrifices were contained in triangular tables of ſtone called *cyrbes*. The Athenian magiſtrates were ſworn to obſerve both; and in proceſs of time theſe monuments of Solon's wiſdom became ſo famous, that all public acts were from them named *Axones* and *Cyrbes*.

48 He goes abroad for ten years.

After the promulgation of the laws, Solon found himſelf obliged to leave Athens, to prevent his being continually teazed for explanations and alterations of them. He therefore pretended an inclination to merchandize, and obtained leave to abſent himſelf for 10 years, during which time he hoped the laws would be grown familiar. From Athens Solon travelled into Egypt, where he converſed with Pſenophis the Heliopolitan, and Sonchis the Saite, the moſt learned prieſts of that age. From theſe he learned the ſituation of the iſland Atlantis, of which he wrote an account in verſe, which Plato afterwards continued*. From Egypt he went to Cyprus, where he was extremely well received by one of the petty kings. This prince lived in a city called *Apeia*, built by Demophon the ſon of Theſeus, on an eminence near the river Clarius, but in a ſoil craggy and barren. Solon obſerving a very pleaſant plain below, engaged the king to remove thither; aſſiſted in executing the ſcheme he had formed; and ſucceeded ſo well, that a new city was formed, which ſoon became populous, and out of gratitude to the Athenian legiſlator was called *Solos*.

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* See *Atlantis*.

49 Things fall into diſorder in his abſence.

But while Solon was thus travelling in queſt of wiſdom, and with a view to benefit thoſe among whom he came, his countrymen, who ſeem to have reſolved on being diſſatisfied at all events, had again divided themſelves into three factions. Lycurgus put himſelf at the head of the country people; Megacles the ſon of Alcmæon was at the head of thoſe who lived on the ſea-coaſt; and Piſiſtratus put himſelf at the head of the poorer ſort, to protect them, as he pretended, from tyranny, but in reality to ſeize on the ſovereignty for himſelf. All the factions pretended to have a vaſt regard for Solon and his laws, at the ſame time that they were very deſirous of a change; but how they were to be bettered, none of them knew, or pretended to know.

50 He returns to Athens, but refuſes to reſume his office.

In the midſt of this confuſion the legiſlator returned. Each of the factions paid their court to him, and affected to receive him with the deepeſt reverence and reſpect; beſeeching him to reaſſume his authority, and compoſe the diſorders which they themſelves kept up. This Solon declined on account of his age, which, he ſaid, rendered him unable to ſpeak and act for the good of his country as formerly: however, he ſent for the chiefs of each party, beſeeching them in the moſt pathetic manner not to ruin their common parent, but to prefer the public good to their own private intereſt.

Piſiſtratus, who of all the three had perhaps the leaſt intention to follow Solon's advice, ſeemed to be the moſt affected with his diſcourſes; but as Solon perceived he affected popularity by all poſſible methods, he eaſily penetrated into his deſigns of aſſuming the ſovereign power. This he ſpoke of to Piſiſtratus himſelf, at firſt privately; but as he ſaw that his admonitions in this way had no effect, he then ſaid the ſame things to others, that the public might be on their guard againſt him.

51 Piſiſtratus aſſumes the ſovereignty

All the wiſe diſcourſes of Solon, however, were loſt upon the Athenians. Piſiſtratus had got the meaner ſort entirely at his devotion, and therefore reſolved to cheat them out of the liberty which they certainly deſerved to loſe. With this view he wounded himſelf, and, as Herodotus ſays, the mules that drew his chariot; then he drove into the market-place, and there ſhowed his bleeding body, imploring the protection of the people from thoſe whom his kindneſs to them had ren-

(B) The Athenians had a cuſtom of hanging up billets to ſhow that houſes were engaged for ſuch and ſuch ſums of money.

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rendered his implacable enemies. A concourſe of people being inſtantly formed, Solon came among the reſt, and, ſuſpecting the deceit, openly taxed Piſiſtratus with his perfidious conduct; but to no purpoſe. A general aſſembly of the people was called, wherein it was moved by one Ariſton, that Piſiſtratus ſhould have a guard. Solon was the only perſon preſent who had reſolution enough to oppoſe this meaſure; the richer Athenians, perceiving that the multitude implicitly followed Piſiſtratus, and applauded every thing he ſaid, remaining ſilent through fear. Solon himſelf, when he ſaw he could prevail nothing, left the aſſembly, ſaying he was *wiſer* than ſome, and *ſtouter* than others. A guard of 400 men was now unanimouſly decreed to Piſiſtratus, as we are told by Solon himſelf. This inconſiderable body he made uſe of to enſlave the people, but in what manner he accompliſhed his purpoſe is not agreed. Certain it is, that with his guard he ſeized the citadel; but Polyænus hath given an account of a very ſingular method which he took to put it out of the power of the Athenians to defend themſelves even againſt ſuch a ſmall number. He ſummoned an aſſembly to be held at the Anacium, and directed that the people ſhould come thither armed. They accordingly came; and Piſiſtratus harangued them, but in a voice ſo low that they could not tell what he ſaid. The people complaining of this, Piſiſtratus told them that they were hindered from hearing him by the clangour of their arms; but if they would lay them down in the portico, he would then be heard diſtinctly. This they did; and while they liſtened very attentively to a long and eloquent oration, Piſiſtratus's guard conveyed away their arms, ſo that they found themſelves deprived of all power of reſiſtance. During the confuſion which followed this event, another aſſembly was held, wherein Solon enveighed bitterly againſt the meanneſs of his countrymen, inviting them to take up arms in defence of their liberty. When he ſaw that nothing would do, he laid down his own arms, ſaying, that he had done his utmoſt for his country and his laws. According to Plutarch, he refuſed to quit the city; but the moſt probable opinion is, that he immediately retired from the dominions of Athens, and refuſed to return, even at the ſolicitation of Piſiſtratus himſelf.

52 Solon leaves Athens.

53 Piſiſtratus governs with great moderation

Piſiſtratus having thus obtained the ſovereignty, did not overturn the laws of Solon, but uſed his power with the greateſt moderation. It is not to be expected, however, that ſo turbulent a people as the Athenians could be ſatisfied by any method of government he could lay down. At the beginning of his adminiſtration, Megacles and his family retired out of Athens to ſave their own lives, yet without deſpairing of being able ſome time or other to return. With this view Megacles and his aſſociates entered into a treaty with Lycurgus; and having brought him and his party into a ſcheme for depoſing Piſiſtratus, they concerted matters ſo well, that Piſiſtratus was ſoon obliged to ſeek for ſhelter ſomewhere elſe, and, on his departure, the Athenians ordered his goods to be ſold. Nobody, however, except one perſon *(Callias)*, would venture to buy any of them, from an apprehenſion, no doubt, that they would ſoon be reſtored to their proper owner, which accordingly happened in a very ſhort time.

54 Driven out by Megacles.

As Megacles and his party had negociated with Lycurgus to turn out Piſiſtratus, ſo they now entered into a treaty with Piſiſtratus to reinſtate him in his principality, as ſoon as they found Lycurgus would not be implicitly governed by them. To accompliſh this, they fell upon a very ridiculous project; which, however, was attended with the deſired ſucceſs. They found out a woman whoſe name was *Hhya*, of a mean family and fortune, but of a great ſtature, and very handſome. Her they dreſſed in armour, placed her in a chariot, and having diſpoſed things ſo as to make her appear with all poſſible advantage, they conducted her towards the city, ſending heralds before, with orders to ſpeak to the people in the following terms: "Give a kind reception, O Athenians, to Piſiſtratus, who is ſo much honoured by Minerva above all other men, that ſhe herſelf condeſcends to bring him back to the citadel." The report being univerſally ſpread that Minerva was bringing home Piſiſtratus, and the ignorant multitude believing this woman to be the goddeſs, addreſſed their prayers to her, and received Piſiſtratus with the utmoſt joy. When he had recovered the ſovereignty, Piſiſtratus married the daughter of Megacles as he had promiſed, and gave the pretended goddeſs to his ſon Hipparchus.

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55 Who ſoon after reinſtates him.

56 Driven out a ſecond time.

Piſiſtratus did not long enjoy the kingdom to which he had been reſtored in ſo ſtrange a manner. He had married the daughter of Megacles, as already obſerved; but having children by a former wife, and remembering that the whole family of Megacles was reprobated by the Athenians, he thought proper to let his new ſpouſe remain in a ſtate of perpetual widowhood. This ſhe patiently bore for ſome time, but at laſt acquainted her mother. An affront ſo grievous could not fail to be highly reſented. Megacles inſtantly entered into a treaty with the malcontents, of whom there were always great plenty at Athens whatever was the form of government. This Piſiſtratus being apprized of, and perceiving a new ſtorm gathering, he voluntarily quitted Athens, and retired to Eretria. Here having conſulted with his ſons, it was reſolved to reduce Athens by force. With this view he applied to ſeveral of the Greek ſtates, who furniſhed him with the troops he deſired, but the Thebans exceeded all the reſt in their liberality; and with this army he returned to Attica, according to Herodotus, in the 11th year of his baniſhment. They firſt reduced Marathon, the inhabitants of which had taken no meaſures for their defence, tho' they knew that Piſiſtratus was preparing to attack them. The republican forces in the mean time marched out of Athens to attack him; but behaving in a ſecure and careleſs manner, they were ſupriſed by Piſiſtratus, and totally routed. While they were endeavouring to make their eſcape, he cauſed his two ſons ride before him with all ſpeed, and tell thoſe they came up with that nobody had any thing to fear, but that they might every one return to his own home. This ſtratagem ſo effectually diſperſed the republican army, that it was impoſſible to rally them, and Piſiſtratus became a third time abſolute maſter of Attica.

57 But returns with an army.

58 He takes poſſeſſion of the city.

Piſiſtratus being once more in poſſeſſion of the ſovereignty, took a method of eſtabliſhing himſelf on the throne directly oppoſite to what Theſeus had done. Inſtead of collecting the inhabitants from the country into cities, Piſiſtratus made them retire from the cities into the country, in order to apply themſelves

59 His ſubjects ſtill diſcontented notwithſtanding his moderation.

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selves to agriculture. This prevented their meeting together, and caballing againſt him in ſuch bodies as they had been accuſtomed to do. By this means alſo the territory of Athens was greatly meliorated, and great plantations of olives were made over all Attica, which had before not only been deſtitute of corn, but alſo bare of trees. He alſo commanded, that, in the city men ſhould wear a kind of ſheep-ſkin veſt, reaching to the knees; but ſo intolerable were the laws of Piſiſtratus to his ſubjects, that this kind of garment in ſucceeding times became proverbially the habit of ſlavery.

As prince of Athens, Piſiſtratus received the tenth part of every man's revenues, and even of the fruits of the earth; and this alſo, though for the ſervice of the ſtate, ſeemed to the Athenians a moſt grievous burden. In ſhort, though Piſiſtratus behaved in all reſpects as a moſt excellent prince, his ſubjects fancied themſelves oppreſſed by tyranny, and were perpetually grumbling from the time he firſt aſcended the throne to the day of his death, which happened about 33 years after he had firſt aſſumed the ſovereignty, of which time, according to Ariſtotle, he reigned 17 years.

60 Hipparchus and Hippias.

Piſiſtratus left behind him two ſons named *Hipparchus* and *Hippias*, both men of great abilities, who ſhared the government between them, and behaved with lenity and moderation. But though by the mildneſs of their government the family of the Piſiſtratidæ ſeemed to be fully eſtabliſhed on the throne of Athens, a conſpiracy was unexpectedly formed againſt both the brothers, by which Hipparchus was taken off, and Hippias narrowly eſcaped. The moſt material facts relating to this conſpiracy are what follow.

61 Conſpiracy of Harmodius and Ariſtogiton.

There were at that time in Athens two young men called *Harmodius* and *Ariſtogiton*; the former of theſe was exquiſitely beautiful in his perſon, and on that account, according to the infamous cuſtom of the Greeks, violently beloved of the other. This Harmodius was alſo beloved of Hipparchus; who, if we may believe Thucydides, forced him. This was grievouſly reſented, and revenge determined on; to haſten which, another accident concurred. Hipparchus finding that Harmodius endeavoured to avoid him, publicly affronted him, by not ſuffering his ſiſter to carry the offering of Minerva, as if ſhe was a perſon unworthy of that office. The two young men, not daring to ſhow any public ſigns of reſentment, conſulted privately with their friends; among whom it was reſolved, that at the approaching feſtival of Panathenæa, when the citizens were allowed to appear in arms, they ſhould attempt to reſtore Athens to its former liberty. In this they imagined that they ſhould find themſelves ſeconded by the whole body of the people. But when the day appointed was come, they perceived one of their number talking very familiarly with Hippias; and fearing that they were diſcovered, they immediately

62 Hipparchus killed.

fell upon Hipparchus, and diſpatched him with a multitude of wounds. In this exploit the people were ſo far from ſeconding them, as they expected, that they ſuffered Harmodius to be killed by Hipparchus's guards, and ſeizing Ariſtogiton themſelves, delivered him up to Hippias. Some time afterwards, however, the reſpect they paid to theſe two young men exceeded all bounds. They cauſed their praiſes to be ſung at the Panathenæa, forbid any citizen to call a ſlave by either of their names, and erected brazen ſtatues to them in the forum; which ſtatues were afterwards carried into Perſia by Xerxes, and ſent back from thence by Alexander the Great, Antiochus, or Seleucus, for authors are not agreed by which. Several immunities and privileges were alſo granted to the deſcendants of the two patriots, and all poſſible means were taken to render their memory venerable and reſpected by poſterity.

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63 The conſpiratorsextravagantly honoured.

64 Cruelty of Hippias.

Hippias being now ſole maſter of Athens, and probably exaſperated by the murder of his brother, began to alter his conduct greatly, and treat his ſubjects in an oppreſſive and cruel manner. He began with torturing Ariſtogiton, in order to make him confeſs his accomplices: but this proved fatal to his own friends; for Ariſtogiton impeaching ſuch as he knew to be beſt affected to Hippias, they were immediately put to death; and when he had deſtroyed all thoſe he knew, at laſt told Hippias, that now he knew of none that deſerved to ſuffer death except the tyrant himſelf. Hippias now vented his rage on a woman named *Leæna*, who was kept by Ariſtogiton. She endured the torture as long as ſhe could; but finding herſelf unable to bear it any longer, ſhe at laſt bit off her tongue, that ſhe might not have it in her power to make any diſcovery. To her the Athenians erected the ſtatue of a lioneſs, alluding to her name, without a tongue, on which was engraved a ſuitable inſcription.

After the conſpiracy was, as Hippias thought, thoroughly quaſhed, he ſet himſelf about ſtrengthening his government by all the means he could think of. He contracted leagues with foreign princes, increaſed his revenues by various methods, &c. But theſe precautions were of little avail: the lenity of Piſiſtratus's government had alone ſupported it; and Hippias purſuing contrary methods, was deprived of the ſovereignty in leſs than four years after the death of his brother.

65 He is driven out of Athens.

This revolution was likewiſe owing to the family of Megacles, who were ſtyled *Alcmæonidæ*, and had ſettled at Lipſydrum. In times of diſcontent, which at Athens were very frequent, this family was the common refuge of all who fled from that city; and at laſt they thought of a method of expelling the Piſiſtratidæ altogether. The method they took to accompliſh their purpoſe was as follow. They agreed with the Amphictyons to rebuild the temple at Delphi; and being poſſeſſed of immenſe riches, they performed their engagements in a much more magnificent manner than they were bound to do; for having agreed only to build the front of common ſtone, they built it of Parian marble. At the ſame time they corrupted the propheteſs Pythia, engaging her to exhort all the Lacedemonians that came to conſult the oracle either in behalf of the ſtate, or their own private affairs, to attempt the delivery of Athens. This had the deſired effect: The Lacedemonians ſupriſed at hearing this admonition inceſſantly repeated, at laſt reſolved to obey the divine command, as they imagined it to be; and ſent Anchimolius, a man of great quality, at the head of an army into Attica, though they were at that time in league with Hippias, and accounted by him his good friends and allies. Hippias demanding aſſiſtance from the Theſſalians, they readily ſent him 1000 horſe,

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under the command of one of their princes named *Cineas*. The Lacedemonians being landed, Hippias fell upon them ſo ſuddenly, that he defeated them with geat ſlaughter, killed their general, and forced the ſhattered remains of their army to fly to their ſhips. The Spartans, incenſed at this unfortunate expedition, determined to ſend another army into Attica; which they accordingly did ſoon after under their king Cleomenes: and he having, at his entrance into the Athenian territories, defeated the Theſſalian horſe, obliged Hippias to ſhut himſelf up in the city of Athens, which he was ſoon after forced to abandon altogether. He was, however, in no want of a place of refuge; the Theſſalian princes inviting him into their country, and the king of Macedon offering his family a city and territory, if they choſe to retire into his dominions. But Hippias choſe rather to go to the city of Sigeum, which Piſiſtratus had conquered, and left to his own family.

66 And retires to Sigeum.

After the expulſion of the Piſiſtratidæ, the Athenians did not long enjoy the quiet they had propoſed to themſelves. They were quickly divided into two factions; at the head of one was Clyſthenes, one of the chiefs of the Alcmæonidæ; and the other, Iſagoras, a man of great quality, and highly in favour with the Athenian nobility. Clyſthenes applied himſelf to the people, and endeavoured to gain their affections by increaſing their power as much as poſſible. Iſagoras perceiving that by this means his rival would get the better, applied to the Lacedemonians for aſſiſtance, reviving at the ſame time the old ſtory of Megacles's ſacrilege, and inſiſting that Clyſthenes ought to be baniſhed as being of the family of Megacles. Cleomenes king of Sparta readily came into his meaſures, and ſuddenly diſpatched an herald to Athens with a declaration of war in caſe all the Alcmæonidæ were not immediately baniſhed. The Athenians did not heſitate to baniſh their benefactor Clyſthenes, and all his relations; but this piece of ingratitude did not anſwer their purpoſe. Cleomenes entered Attica at the head of a Spartan army; and, arriving at Athens, condemned to baniſhment 700 families more than what had been ſent into exile before. Not content with this, he would have diſſolved the ſenate, and veſted the government in 300 of the chief of Iſagoras's faction. This the Athenians would by no means ſubmit to; and therefore took up arms, and drove Cleomenes and his troops into the citadel, where they were beſieged for two days. On the third day Cleomenes ſurrendered, on condition that all thoſe who were in the citadel ſhould retire unmoleſted. This, though agreed to, was not performed by the Athenians. They fell upon ſuch as were ſeparated from the army, and put them to death without mercy. Among the number of thoſe ſlain on this occaſion was Timeſitheus the brother of Cleomenes himſelf.

67 Two factions in Athens.

68 The Spartans ſupport Iſagoras.

69 But without ſucceſs.

The Spartan king was no ſooner withdrawn from Athens, than he formed a ſtrong combination in favour of Iſagoras. He engaged the Bœotians to attack Attica on the one ſide, and the Chalcidians on the other, while he at the head of a powerful Spartan army entered the territories of Eleuſina. In this diſtreſs, the Athenians, not being able to cope with ſo many enemies at once, reſolved to ſuffer their territories to be ravaged by the Chalcidians and Bœotians, contenting themſelves with oppoſing the army commanded by Cleomenes in perſon. But this powerful confederacy was quickly diſſolved: the Corinthians, who were allied with Cleomenes, doubting the juſtice of their cauſe, returned home; his other allies likewiſe beginning to waver, and his colleague Ariſton, the other king of Sparta, differing in ſentiments, Cleomenes was obliged to abandon the enterpriſe. The Spartans and their allies being withdrawn, the Athenians took a ſevere revenge of the Bœotians and Chalcidians, totally routing their forces, and carrying off a great number of priſoners. The priſoners taken in this war were put in irons, but afterwards ſet at liberty on paying a ranſom of two minæ per head. Their fetters were, however, hung up in the citadel; and the Athenians conſecrated the tenth of what they had received for ranſom, purchaſed a ſtatue, repreſenting a chariot and four horſes, which they ſet up in the portico of the citadel, with a triumphant inſcription in token of their victory.

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70 Bœotians and Chalcidians defeated.

Theſe indignities rouſing the Bœotians, they immediately vowed revenge, and engaged on their ſide the people of Ægina, who had an hereditary hatred at the Athenians; and while the latter bent all their attention to the Bœotian war, the Ægenitans landing a conſiderable army, ravaged the coaſts of Attica.

71 Attempt of the Spartans to reſtore Hippias.

But while the Athenians were thus employed againſt the Bœotians and Æginetans, a jealouſy ſprung up on the part of Lacedæmon, which was never afterwards eradicated. Cleomenes, after his unſucceſsful expedition againſt Attica, produced at Sparta certain oracles which he ſaid he had found in the citadel of Athens while he was beſieged therein: the purport of theſe oracles was, that Athens would in time become a rival to Sparta. At the ſame time it was diſcovered, that Clyſthenes had bribed the prieſteſs of Apollo to cauſe the Lacedæmonians expel the Piſiſtratidæ from Athens; which was ſacrificing their beſt friends to thoſe whom intereſt obliged to be their enemies. This had ſuch an effect, that the Spartans, repenting their folly in expelling Hippias, ſent for him from Sigeum, in order to reſtore him to his principality: but this not being agreed to by the reſt of the ſtates, they were forced to abandon the enterpriſe, and Hippias returned to Sigeum as he came.

72 Cauſe of the war with Perſia.

About this time too, Ariſtagoras the Mileſian having ſet on foot a revolt in Ionia againſt the Perſian king, applied to the Spartans for aſſiſtance; but they declining to have any hand in the matter, he next applied to the Athenians, and was by them furniſhed with 20 ſhips under the command of Melanthus, a nobleman univerſally eſteemed. This raſh action coſt the Greeks very dear, as it brought upon them the whole power of the Perſian empire; for no ſooner did the king of Perſia hear of the aſſiſtance ſent from Athens to his rebellious ſubjects, than he declared himſelf the ſworn enemy of that city, and ſolemnly beſought God that he might one day have it in his power to be revenged on them.

The Ionian war being ended, by the reduction of that country again under the Perſian government, the king of Perſia ſent to demand earth and water as tokens of ſubmiſſion from the Greeks. Moſt of the iſlanders yielded to this command out of fear, and among the reſt the people of Ægina; upon which the Athenians accuſed

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accuſed the inhabitants of this iſland of treachery towards Greece, and a war was carried on with them for a long time. How it ended we are not informed; but its continuance was fortunate for Greece in general, as, by inuring them to war, and ſea-affairs in particular, it prevented the whole of the Grecian ſtates from being ſwallowed up by the Perſians who were now about to invade them.

Beſides the diſpleaſure which Darius had conceived againſt the Athenians on account of the aſſiſtance they had afforded the Ionians, he was further engaged to an expedition againſt Greece by the intrigues of Hippias.

73 Hippias applies to the Perſians.

Immediately on his returning unſucceſsfully from Lacedemon, as above related, Hippias paſſed over into Aſia, went to Artaphernes governor of the adjacent provinces belonging to the Perſian king, and excited him to make war upon his country, promiſing to be obedient to the Perſian monarch provided he was reſtored to the principality of Athens. Of this the Athenians being apprized, ſent ambaſſadors to Artaphernes, deſiring leave to enjoy their liberty in quiet: but that nobleman returned for anſwer, that if they would have peace with the great king, they muſt immediately receive Hippias; upon which anſwer the Athenians reſolved to aſſiſt the enemies of Darius as much as poſſible. The conſequence of this reſolution was, that Darius commiſſioned Mardonius to revenge him of the inſults he thought the Greeks had offered him. But Mardonius having met with a ſtorm at ſea, and other accidents, which rendered him unable to do any thing, Datis and Artaphernes the ſon of Artaphernes abovementioned, were commiſſioned to do what he was to have done.

74 They invade Greece.

The Perſian commanders, fearing again to attempt to double the promontory of Athos, where their fleet had formerly ſuffered, drew their forces into the plains of Celicia; and paſſing from thence through the Cyclades to Eubœa, directed their courſe to Athens. Their charge from Darius was to deſtroy both Eretria and Athens; and to bring away the inhabitants, that they might be at his diſpoſal. Their firſt attempt was

75 Eretria deſtroyed.

on Eretria, the inhabitants of which ſent to Athens for aſſiſtance on the firſt approach of the Perſian fleet. The Athenians, with a magnanimity almoſt unparalleled at ſuch a juncture, ſent 4000 men to their aſſiſtance; but the Eretrians were ſo much divided among themſelves, that nothing could be reſolved on. One party among them was for receiving the Athenian ſuccours into the city; another, for abandoning the city and retiring into the mountains of Eubœa; while a third ſought to betray their country to the Perſians for their own private intereſt. Seeing things in this ſituation, therefore, and that no good could poſſibly be done, one Æſchines, a man of great authority among the Eretrians, generouſly informed the Athenians commanders that they might return home. They accordingly retired to Oropus, by which means they eſcaped deſtruction: for Eretria being ſoon after betrayed to the Perſians, was pillaged, burnt, and its inhabitants ſold for ſlaves.

On the news of this diſaſter the Athenians immediately drew together all the forces they were able, which after all amounted to no more than 9000 men. Theſe, with 1000 Platæans who afterwards joined them, were commanded by ten general officers, who had equal power; among whom were Miltiades, Ariſtides, and Themiſtocles, men of diſtinguiſhed valour and great abilities. But it being generally imagined that ſo ſmall a body of troops would be unable to reſiſt the formidable power of the Perſians, a meſſenger was diſpatched to Sparta to intreat the immediate aſſiſtance of that ſtate. He communicated his buſineſs to the ſenate in the following terms: "Men of Lacedæmon, the Athenians deſire you to aſſiſt them, and not to ſuffer the moſt ancient of all the Grecian cities to be enſlaved by the barbarians. Eretria is already deſtroyed, and Greece conſequently weakened by the loſs of ſo conſiderable a place." The aſſiſtance was readily granted; but at the ſame time the ſuccours arrived ſo ſlowly, that the Athenians were forced to fight without them. In this memorable engagement in the plans of Marathon, whither Hippias had conducted the Perſians, the latter were defeated with the loſs of 6300 men, while the Greeks loſt only 192. The Perſians being thus driven to their ſhips, endeavoured to double Cape Sunium, in order to ſurprize Athens itſelf before the army could return: but in this they were prevented by Miltiades; who leaving Ariſtides with 1000 men to guard the priſoners, returned ſo expeditiouſly with the other 9000, that he was at the temple of Hercules, which was but a ſmall way diſtant, before the barbarians could attack the city.

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76 Perſians defeated at Marathon.

77 Integrity of Ariſtides.

After the battle, Ariſtides diſcharged the truſt repoſed in him with the greateſt integrity. Though there was much gold and ſilver in the Perſian camp, and the tents and ſhips they had taken were filled with all ſorts of riches, he not only forbore touching any thing himſelf, but to the utmoſt of his power prevented others from doing it. Some, however, found means to enrich themſelves; among the reſt, one Callias, couſin-german to Ariſtides himſelf. This man being a torch-bearer, and, in virtue of his office, having a fillet on his head, one of the Perſians took him for a king, and, falling down at his feet, diſcovered to him a vaſt quantity of gold hid in a well. Callias not only ſeized, and applied it to his own uſe, but had the cruelty to kill the poor man who diſcovered it to him, that he might not mention it to others; by which infamous action he entailed on his poſterity the name of *Laccopluti*, or *enriched by the well*.

78 Miltiades ungratefully treated by the Athenians.

After the battle of Marathon, all the inhabitants of Platæa were declared free citizens of Athens, and Miltiades, Themiſtocles, and Ariſtides, were treated with all poſſible marks of gratitude and reſpect. This, however, was but very ſhort-lived; Miltiades propoſed an expedition againſt the iſland of Paros, in which having been unſucceſsful, through what cauſe is not well known, he was, on his return, accuſed, and condemned to pay 50 talents, the whole expence of the ſcheme; and being unable to pay the debt was thrown into priſon, where he ſoon died of a wound received at Paros.

79 As likewiſe Ariſtides.

If any thing can exceed the enormity of ſuch a proceeding as this, it was the treatment Ariſtides next received. Miltiades had propoſed an expedition which had not proved ſucceſsful, and in which he might poſſibly have had bad deſigns; but againſt Ariſtides not ſo much as a ſhadow of guilt was pretended. On the contrary, his extraordinary virtue had procured him the title of *Juſt*, and he had never been found to ſwerve

from

Attica. from the maxims of equity. His downfal was occaſioned by the intrigues of Themiſtocles: who being a man of great abilities, and hating Ariſtides on account of the character he deſervedly bore among his countrymen, took all opportunities of inſinuating that his rival had in fact made himſelf maſter of Athens without the parade of guards and royalty. "He gives laws to the people (ſaid he); and what conſtitutes a tyrant, but giving laws?" In conſequence of this ſtrange argument, a ſtrong party was formed againſt the virtuous Ariſtides, and it was reſolved to baniſh him for 10 years by the oſtraciſm. In this caſe, the name of the perſon to be baniſhed was written upon a ſhell by every one who deſired his exile, and carried to a certain place within the forum incloſed with rails. If the number of ſhells ſo collected exceeded 6000, the ſentence was inflicted; if not, it was otherwiſe. When the agents of Themiſtocles had ſufficiently accompliſhed their purpoſe, on a ſudden the people flocked to the forum deſiring the oſtraciſm. One of the clowns who had come from a borough in the country, bringing a ſhell to Ariſtides, ſaid to him, "Write me Ariſtides upon this." Ariſtides, ſurpriſed, aſked him if he knew any ill of that Athenian, or if he had ever done him any hurt? "Me hurt! (ſaid the fellow), no, I don't ſo much as know him; but I am weary and ſick at heart on hearing him every where called *the juſt*." Ariſtides therefore took the ſhell, and wrote his own name upon it; and when informed that the oſtraciſm fell upon him, modeſtly retired out of the forum, ſaying, "I beſeech the gods that the Athenians may never ſee that day which ſhall force them to remember Ariſtides."

After the battle of Marathon, the war with Ægina was revived with great vigour; but the Æginetans generally had the ſuperiority, on account of their great naval power. Themiſtocles obſerving this, was continually exhorting his countrymen to build a fleet, not only to make them an equal match for the Æginetans, but alſo becauſe he was of opinion that the Perſians would ſoon pay them another viſit. At laſt, he had the boldneſs to propoſe, that the money produced by the ſilver mines, which the Athenians had hitherto divided among themſelves, ſhould be applied to the building of a fleet: which propoſal being complied with, 100 galleys were immediately put upon the ſtocks; and this ſudden increaſe of the maritime power proved the means of ſaving all Greece from ſlavery.

80 Themiſtocles adviſes the building of a fleet.

About three years after the baniſhment of Ariſtides, Xerxes king of Perſia ſent to demand earth and water: but Themiſtocles deſiring to make the breach with that monarch ſtill wider, put to death the interpreter for publiſhing the decree of the king of Perſia in the language of the Greeks; and having prevailed upon the ſeveral ſtates to lay aſide their animoſities, and provide for their common ſafety, got himſelf elected general of the Athenian army.

81 Xerxes invades Greece.

When the news arrived that the Perſians were advancing to invade Greece by the ſtraits of Thermopylæ, and that they were for this purpoſe tranſporting their forces by ſea, Themiſtocles adviſed his countrymen to quit the city, embark on board their galleys, and meet their enemies while yet at a diſtance. This they would by no means comply with; for which reaſon Themiſtocles put himſelf at the head of the army, and having joined the Lacedemonians, marched towards Tempe. Here, having received advice that the ſtraits of Thermopylæ were forced, and that both Bœotia and Theſſaly had ſubmitted to the Perſians, the army returned without doing any thing. Attica.

In this diſtreſs the Athenians applied to the oracle at Delphi: from whence they received at firſt a very ſevere anſwer, threatening them with total deſtruction; but after much humiliation, a more favourable one was delivered, in which, probably by the direction of Themiſtocles, they were promiſed ſafety in *walls of wood*. This was by Themiſtocles and the greateſt part of the citizens interpreted as a command to abandon Athens, and put all their hopes of ſafety in their fleet. Upon this, the opinion of Themiſtocles prevailing, the greateſt part began to prepare for this embarkation; and had money diſtributed among them by the council of the Areopagus, to the amount of eight drachms per man; but this not proving ſufficient, Themiſtocles gave out that ſomebody had ſtolen the ſhield of Minerva; under pretence of ſearching for which, he ſeized on all the money he could find. Some, however, there were who refuſed to embark with the reſt, but raiſed to themſelves fortifications of wood; underſtanding the oracle in its literal ſenſe, and reſolving to wait the arrival of the Perſians, and defend themſelves to the laſt. In the mean time Ariſtides was recalled, when the Athenians ſaw it their intereſt, leſt he ſhould have gone over to the Perſians and aſſiſted them with his advice.

82 Athens abandoned by its inhabitants.

The Perſians having advanced to Athens ſoon after the inhabitants had deſerted it, met with no oppoſition except from the few juſt now mentioned; who, as they would hearken to no terms of accommodation, were all cut in pieces, and the city utterly deſtroyed. Xerxes, however, being defeated in a ſea-fight at Salamis, was forced to fly with prodigious loſs. See SALAMIS. Themiſtocles was for purſuing him, and breaking down the bridge he had caſt over the Helleſpont; but this advice being rejected, he ſent a truſty meſſenger to Xerxes, acquainting him that the Greeks intended to break down his bridge, and therefore deſired him to make all the haſte he could, leſt by that means he ſhould be ſhut up in Europe. According to Herodotus, he a ſo adviſed the Athenians to quit the purſuit and return home, in order to build their ruined houſes. This advice, though miſinterpreted by ſome, was certainly a very prudent one, as Xerxes, though once defeated, was ſtill at the head of an army capable of deſtroying all Greece; and had he been driven to deſpair by finding himſelf ſhut up, or warmly purſued, it was impoſſible to ſay what might have been the event. After this, Themiſtocles formed a ſcheme, for the aggrandiſement of Athens indeed, but a moſt unjuſt and infamous one. It was, in ſhort, to make Athens miſtreſs of the ſea by burning all the ſhips except thoſe belonging to that republic. He told his countrymen that he had ſomething to propoſe of great conſequence, but which could not be ſpoken publicly: whereupon he was deſired to communicate it to Ariſtides, by whom the propoſal was rejected; and Ariſtides having informed the Athenians that what Themiſtocles had ſaid was very advantageous but very unjuſt, they deſired him to think no more of it.

83 And deſtroyed by the Perſians.

84 They are totally defeated at Salamis.

When the fleet returned to Salamis, extraordinary honours were paid to Themiſtocles by the Lacedemonians. On his entering that city, they decreed him a wreath

85 Themiſtocles honoured by the Lacedemonians.

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wreath of olive as the prize of prudence; preſented him with the moſt magnificent chariot in Sparta; and when he returned to Athens, he was eſcorted by 500 horſe, an honour never paid to any ſtranger but himſelf. On his arrival at Athens, however, there were not wanting ſome who inſinuated that the receiving ſuch honours from the Lacedemonians was injurious to the republic; but Themiſtocles confiding in his innocence, treated theſe clamours with contempt, and exhorted his countrymen to entertain no doubts of their allies, but rather endeavour to preſerve the great reputation they had acquired throughout all Greece.

The defeat of Xerxes at Salamis made Mardonius, who was left to carry on the war by land, more ready to treat with the Athenians than to fight them; and with this view he ſent Alexander king of Macedon to Athens to make propoſals of alliance with that republic, excluſively of all the other Grecian ſtates. This propoſal, however, was rejected; and the conſequence was, that Athens was a ſecond time deſtroyed, the Spartans ſending aſſiſtance ſo ſlowly, that the Athenians were forced to retire to Salamis: but they were ſoon freed from all apprehenſions by the total defeat and death of Mardonius at Platæa; where Ariſtides, and the body of troops under his command, diſtinguiſhed themſelves in a moſt extraordinary manner.

86 Athens a ſecond time deſtroyed.

87 The Perſians defeated at Platæa and Mycale.

The ſame day that the battle of Platæa was fought, the Perſians were defeated in a ſea-fight at Mycale in Ionia, wherein it was allowed that the Athenians who were there behaved better than any of the other Greeks; but when it was propoſed to tranſport the Ionians into Europe, that they might be in perfect ſafety, and give them the territories of ſuch Grecian ſtates as had ſided with the Perſians, the Athenians refuſed to comply, fearing the Ionians would rival them in trade, or refuſe the obedience they uſed to pay them: beſides which, they would then loſe the opportunity of plundering the Perſians in caſe of any quarrel with Ionia. Before they returned home, however, the Athenians croſſed over to the Cherſoneſus, and beſieged Seſtos. The ſiege was long and troubleſome: but at laſt the garriſon, being preſſed with hunger, and having no hopes of relief, divided themſelves into two bodies, and endeavoured to make their eſcape; but were purſued, and all either killed or taken. *Oibazus*, one of their commanders, was ſacrificed to a Thracian god; and the other, called *Artyactes*, impaled alive, and his ſon ſtoned before his face, becauſe he had rifled the ſepulchre of Proteſilaus.

88 Seſtos taken by the Athenians.

89 They rebuild their city.

After the victories at Platæa and Mycale, the Athenians returned without any apprehenſion, and began to rebuild their city in a more magnificent manner than before. Here they were no ſooner arrived than a diſpute was ready to be commenced about the form of government. The commons, with Themiſtocles at their head, were for a democracy; to which Ariſtides, rather than hazard the raiſing diſturbances, conſented. It was therefore propoſed, that every citizen ſhould have an equal right to the government; and that the archons ſhould be choſen out of the body of the people, without preference or diſtinction: and this propoſal being agreed to, put an end to all diſcontents for the preſent.

At this time alſo Themiſtocles propoſed that the city of Athens ſhould be fortified in the beſt manner poſſible, that it might not be liable to be again deſtroyed, when the Perſians ſhould take it into their heads to invade Greece. At this propoſal the Lacedemonians were exceedingly alarmed; and therefore remonſtrated, that ſhould Athens once be ſtrongly fortified, and the Perſians become poſſeſſed of it, it would be impoſſible to get them out of it again. At laſt, ſeeing theſe arguments had no effect, they abſolutely forbid the Athenians to carry their walls any higher. This command gave great offence; but Themiſtocles, conſidering the power of Sparta at that time, adviſed the Athenians to temporize; and to aſſure the ambaſſadors, that they ſhould proceed no farther in their work, till by an embaſſy of their own, ſatisfaction ſhould be given to their allies. Being named ambaſſador at his own deſire to Sparta, with ſome other Athenians, Themiſtocles ſet out alone, telling the ſenate that it would be for the intereſt of the ſtate to delay ſending the other ambaſſadors as long as poſſible. When arrived at Sparta, he put off from time to time receiving an audience, on account of his colleagues not being arrived: but in the mean time the walls of Athens were building with the utmoſt expedition; neither houſes nor ſepulchres being ſpared for materials; and men, women, children, ſtrangers, citizens and ſervants, working without intermiſſion. Of this the Lacedemonians having notice, and the reſt of the Athenian ambaſſadors being arrived, Themiſtocles and his colleagues being ſummoned before the ephori, who immediately began to exclaim againſt the Athenians for their breach of promiſe. Themiſtocles denied the charge: he ſaid his colleagues aſſured him of the contrary: that it did not become a great ſtate to give heed to vague reports, but that deputies ought to be ſent from Sparta to inquire into the truth of the matter, and that he himſelf would remain as a hoſtage, to be anſwerable for the event. This being agreed to, he engaged his aſſociates to adviſe the Athenians to commit the Spartan ambaſſadors to ſafe cuſtody till he ſhould be releaſed; after which he publicly avowed the whole tranſaction, took the ſcheme upon himſelf, and told the Lacedemonians that "all things are lawful for our country." The Spartans ſeeing no remedy, concealed their reſentment, and ſent Themiſtocles home in ſafety.

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90 Themiſtocles adviſes to fortify Athens, and deceives the Spartans who oppoſe it.

91 Makes the Pyræum the port of Athens.

The next year, being the laſt of the 75th Olympiad, Themiſtocles obſerving the inconvenience of the port Phalerum, thought of making the *Pyræum* the port of Athens. This he did not at firſt think proper to mention publicly; but having ſignified to the people that he had ſomething of importance to communicate, they appointed Xantippus and Ariſtides to judge of his propoſal. They readily came into his meaſures, and told the people that what Themiſtocles propoſed would be of the utmoſt advantage to the ſtate, at the ſame time that it might be performed with eaſe. Upon this they were deſired to lay the matter before the ſenate; who coming unanimouſly into their meaſure, ambaſſadors were diſpatched to Sparta to inſinuate there how proper it would be for the Greeks to have ſome great port, where a fleet might always watch the deſigns of the Perſians; and thus having prevented any umbrage from their firſt undertakings, the work was ſet about with ſuch expedition, that it was finiſhed before the Lacedemonians knew well what they were about.

At this time alſo the ſovereignty of the ſea was trans-

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transferred from Sparta to Athens, through the haughty behaviour of Pauſanius the Lacedemonian. He had commanded at Platæa, and ſtill enjoyed the ſupreme authority in the war which was all this time carrying on againſt the Perſians; but being elated with his ſucceſs at Platæa, and having entered into a treaſonable correſpondence with the enemy, he treated the captains under his command with the greateſt haughtineſs, giving the preference to the Spartans in ſuch a manner that the reſt of the Greeks could no longer bear his inſolence. On the contrary, Ariſtides, and Cimon the ſon of Miltiades, who commanded the Athenians, by their obliging behaviour gained the favour of every body; ſo that the allies, having publicly affronted Pauſanias, put themſelves under the protection of the Athenian republic; and thenceforward the Athenians, and not the Lacedemonians, had the ſupreme command.

92 Sovereignty of the ſea transferred to Athens.

93 Ariſtides taxes Greece with extraordinary applauſe.

The Greeks being now ſenſible that they would always have occaſion to be on their guard againſt the Perſians, and that it was neceſſary to eſtabliſh a fund by a common taxation of all the ſtates, Ariſtides was pitched upon as the only perſon that could be truſted with the power of allotting to each of the ſtates its proper quota. This difficult taſk he undertook, and executed in a manner unparalleled in the annals of hiſtory. All parties were pleaſed, and his taxation was ſtyled *the happy lot of Greece*. The groſs amount of it was 450 talents.

94 Themiſtocles baniſhed.

It now came to the turn of Themiſtocles to experience the ingratitude of his countrymen. His ſervices had been ſo eſſential, that the treatment he received may perhaps be a ſufficient excuſe for modern patriots when they connect their own intereſt with the ſervice of their country. Themiſtocles had plainly ſaved the ſtate from ruin by his advice; he had diſtinguiſhed himſelf by his valour; had rendered Athens, by his policy, ſuperior to the other ſtates of Greece; and entirely ſubverted the Lacedemonian ſcheme of power. Yet notwithſtanding all this he was baniſhed by the oſtraciſm, without the ſmalleſt crime pretended, unleſs that he was hated by the Lacedemonians, and that he had erected a temple, near his own houſe, dedicated to *Diana, the giver of the beſt counſel*; intimating that he himſelf had given the beſt council for the ſafety both of Athens and of all Greece, which was no more than the truth. Nay, he was not only driven out of Athens, but out of all Greece; ſo that he was forced to ſeek ſhelter from the king of Perſia, againſt whom he had fought with ſo much valour. That monarch gave him a gracious reception; and he was never recalled, becauſe the Greeks had no occaſion for his ſervices.

95 Succeſs of Cimon againſt the Perſians.

The war with Perſia was not yet diſcontinued; the Greeks found their advantage in plundering and enriching themſelves with the ſpoils of the king of Perſia's ſubjects. For this reaſon, in the end of the 77th Olympiad, they equipped a navy, under a pretence of relieving ſuch of the Greek cities in Aſia as were ſubject to the Perſians. Of this fleet Cimon, the ſon of Miltiades by the daughter of the king of Thrace, was appointed commander in chief. He had already taſted the juſtice and generoſity of his countrymen, having been thrown into priſon for his father's fine, from which he was releaſed by *Callias*, whom his ſiſter Elpinice married on account of his great wealth procured by no very honourable means. He accepted of the command, however; and gained ſuch immenſe booty in this expedition, that the Athenians were thereby enabled to lay the foundation of thoſe long extended walls which united the port to the city. The foundation was laid in a mooriſh ground; ſo that they were forced to ſink it very deep, and at a great expence; but to this Cimon himſelf contributed out of his own ſhare of the ſpoils, which was very conſiderable. He alſo adorned the forum with palm trees, and beautified the academy with delightful walks and fountains.

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96 He ſubdues the Cherſoneſus.

The Perſians having ſoon after this expedition invaded Cherſoneſus, and with the aſſiſtance of the Thracians made themſelves maſters of it, Cimon was ſent againſt them in a great hurry. He had only four ſhips; but nevertheleſs with theſe he took 13 of the Perſian galleys, and reduced the whole of the Cherſoneſus. After this he marched againſt the Thracians, who revolting againſt the Athenians, had made themſelves maſters of the gold mines lying between the rivers Nyſſus and Strymon. The Thracians were quickly obliged to yield; after which the Athenians ſent a great colony to Amphipolis a city of Thrace, which for ſome time made a conſiderable figure, but afterwards attempting to penetrate into the country of the *Edones*, great part of them were deſtroyed.

97 Makes Athens irreſiſtable at ſea.

Cimon alſo fell upon the following expedient to make Athens irreſiſtable at ſea by the other ſtates of Greece. Many of the Greek ſtates, by virtue of Ariſtides's taxation, were bound to furniſh men and galleys, as well as to pay the tax for their ſupport. But when they ſaw themſelves out of danger from the Perſians, moſt of them were very unwilling to furniſh their quota of men. This the Athenian generals being offended with, were for having recourſe to force; but Cimon permitted ſuch as were deſirous of ſtaying at home to do ſo, and accepted a ſum of money in lieu of a galley completely manned. By this means he inured the Athenians, whom he took on board his galleys, to hardſhip and diſcipline; while the allies who remained at home became enervated through idleneſs, and from being confederates, dwindled into tributaries, and almoſt ſlaves. In the laſt year of the 77th Olympiad, Cimon was ſent to aſſiſt the Lacedemonians againſt the Helotes, who had revolted from them. In this he was attended with his uſual ſucceſs; but, ſome time after, the Lacedemonians being engaged in the ſiege of Ithome, ſent again to the Athenians for ſuccour, and Cimon was a ſecond time ſent to their relief; but the Spartans having received a ſufficient ſupply of troops from other quarters before the arrival of the Athenian general, he and his men were diſmiſſed without doing any thing. This grievouſly offended the people of Athens, who thenceforward hated not only the Lacedemonians, but all their own citizens who were thought to be friends to that ſtate.

98 He is baniſhed.

It was not poſſible, however, that any perſon who had ſerved the ſtate ſhould eſcape baniſhment at Athens. Cimon had gained great wealth both to the public and to himſelf. In his public character he had behaved with unimpeached honeſty, and as a private citizen he dedicated his wealth to the moſt excellent purpoſes. He demoliſhed the incloſures about his grounds and gardens, permitting every one to enter and take what fruits they pleaſed; he kept an open table,

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table, where both rich and poor were plentifully entertained. If he met a citizen in a tattered ſuit of clothes, he made ſome of his attendants exchange with him; or if the quality of the perſon rendered that kindneſs unſuitable, he cauſed a ſum of money to be privately given him. All this, however, was not ſufficient: he did not concur with every meaſure of the commonalty; and therefore the popular party determined not to baniſh him, but to put him to death. The crime laid to his charge was, that by preſents from the Macedonians he was prevailed upon to let ſlip a manifeſt opportunity of enlarging his conqueſts, after taking from the Perſians the gold mines of Thrace. To this accuſation Cimon replied, that to the utmoſt of his power he had proſecuted the war againſt the Thracians and other enemies of the ſtate of Athens; but that it was true he had not made any inroads into Macedonia, becauſe he did not imagine he was to act as a public enemy of mankind, and becauſe he was ſtruck with reſpect for a nation modeſt in their carriage, juſt in their dealings, and ſtrictly honourable in their behaviour towards him and the Athenians: that if his countrymen looked upon this as a crime, he muſt abide their judgment; but, for his part, he could never be brought to think ſuch conduct amiſs. Elpinice, Cimon's ſiſter, uſed all her intereſt in his behalf, and amongſt others ſpoke to Pericles the celebrated ſtateſman and orator. He was indeed Cimon's rival, and had no doubt aſſiſted in ſtirring up the proſecution againſt him; but he did not deſire his death: and therefore, though appointed to accuſe him, Pericles ſpoke in ſuch a manner that it plainly appeared he did not think him guilty; and, in conſequence of this lenity, Cimon was only baniſhed by the oſtraciſm.

The Athenian power was now riſen to ſuch an height, that all the other ſtates of Peloponneſus looked upon this republic with a jealous eye, and were continually watching every opportunity of making war upon it when the ſtate was engaged in troubleſome affairs, and ſeemed to be leſs able to reſiſt. Theſe attempts, however, ſo far from leſſening, generally contributed to increaſe the power of the Athenians; but in the year before Chriſt 458, the republic entered into a war with Sparta, which was ſcarce put an end to but by the deſtruction of the city of Athens. For this war, there was no recent provocation on the part of the Spartans. They had ſent a great army to aſſiſt the Dorians againſt the Phocians, and the Athenians took this opportunity to revenge themſelves of former quarrels. Having therefore drawn in the Argives and Theſſalians to be their confederates, they poſted themſelves on the Iſthmus, ſo that the Spartan army could not return without engaging them. The Athenians and their confederates amounted to 14,000, and the Spartans to 11,500. The Spartan general, however, not very willing to hazard a battle, turned aſide to Tanagra, a city in Bœotia, where ſome of the Athenians who inclined to ariſtocracy entered into a correſpondence with him. But before their deſigns were ripe for execution, the Athenian army marched with great expedition to Tanagra, ſo that a battle became inevitable. When the armies were drawing up in order of battle, Cimon preſented himſelf before his countrymen in complete armour, and went to take poſt among thoſe of his own tribe; but the popular party raiſed ſuch a clamour againſt him, that he was forced to retire. Before he departed, however, he exhorted Euthippus and the reſt of his friends to behave in ſuch a manner that they might wipe off the aſperſion thrown upon him, as if he had deſigned to betray his country's cauſe to the Lacedemonians. Euthippus deſired him to leave his armour, which he did; and a battle enſuing, the Athenians were defeated with great loſs, and Euthippus with the reſt of Cimon's friends were all killed in defence of his armour which they had ſurrounded. Another engagement ſoon followed, wherein both armies ſuffered ſo much, that they were glad to conclude a ſhort truce, that each might have time to recruit their ſhattered forces.

99 War between Athens and Sparta.

100 Athenians defeated.

101 They gain great advantages over the Spartans.

The ſcale of fortune now ſeemed to turn in favour of the Athenians. The Thebans, who had been deprived of the command of Bœotia on account of their having ſided with Xerxes, were now reſtored to it by the Lacedemonians. At this the Athenians were ſo diſpleaſed, that they ſent an army under Myronides the ſon of Callias into Bœotia to overturn all that had been done. That general was met by the Thebans and their allies, who compoſed a numerous and well-diſciplined army. Nevertheleſs, though the Athenian army was but an handful in compariſon of their enemies, Myronides gained a complete victory over the allies, in ſome ſenſe more glorious than either that of Marathon or Platæa. In theſe battles they had fought againſt effeminate and ill-diſciplined Perſians, but now they encountered and defeated a ſuperior army compoſed of the braveſt Greeks. After this victory, Myronides marched to Tanagra; which he took by ſtorm, and razed to the ground: he then plundered Bœotia; defeated another army which the Bœotians had drawn together to oppoſe him; then fell upon the Locrians; and, having penetrated into Theſſaly, chaſtiſed the inhabitants of that country for having revolted from the Athenians, and from thence returned to Athens laden with riches and glory.

The next year Tolmides the Athenian admiral invaded Laconia, where he made himſelf maſter of ſeveral places; and on the back of this, Pericles invaded Peloponneſus with great ſucceſs, burning, ſpoiling, or taking whatever places he attempted. On his return he found the people greatly out of humour on account of Cimon's baniſhment; ſo he was immediately recalled.

102 Cimon recalled.

Cimon was no ſooner returned than he fell to his old employment of plundering the Perſians; and, according to Plutarch, he had now nothing leſs in view than the conqueſt of the whole Perſian empire. The Perſian monarch finding he could have no reſt, at laſt ſent orders to Artabazus and Megabizus, his commanders, to conclude a treaty; which was done on the following conditions: 1. That the Greek cities in Aſia ſhould be free, and governed by their own laws. 2. That the Perſians ſhould ſend no army within three days journey of the ſea. 3. That no Perſian ſhip of war would ſail between Theſalis and Cyrene, the former a city of Pamphylia, and the latter of Lycia.

103 His death.

While this treaty was carrying on Cimon died, whether of ſickneſs or of a wound he had received is not known; and after his death the Athenian affairs began to fall into confuſion. It was now the misfortune of this ſtate to be alike hated by her enemies and allies; the conſequence of which was, that the latter were perpetually

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petually revolting whenever they thought they had an opportunity of doing ſo with impunity. The Megarians, at this time, who had been long under the protection or dominion of Athens, thought proper for ſome reaſon or other to diſclaim all dependence on their former protectors, and have recourſe to Sparta, with which ſtate they entered into a ſtrict alliance. This the Athenians revenged by ravaging the country of the Megarians; which ſoon brought on a renewal of the Lacedemonian war that had been for a little time ſuſpended. Pericles, however, procured the return of the firſt Lacedemonian army, without bloodſhed, by bribing Chandrides the young king of Sparta's tutor. In the winter, Tolmides reſolved to undertake an expedition into Bœotia with a ſmall body of troops; which deſign he put in execution contrary to the advice of Pericles, and his raſhneſs was ſoon puniſhed by his own death and the total defeat of his army. Notwithſtanding this misfortune, however, Pericles ſoon after invaded and reduced Eubœa; and the Lacedemonians, finding it was not for their intereſt to carry on the war, concluded a truce with the Athenians for 30 years.

104 A thirty years truce with the Lacedemonians.

About this time Pſammiticus, king of Egypt, ſent by way of preſent to the people of Athens 40,000 buſhels of wheat; which proved a great misfortune to the city: for Pericles, out of ſpite to Cimon, who had children by an Arcadian woman, had preferred a law whereby the Athenians of the half-blood were diſfranchiſed; and this law, on account of the diſtribution of the corn abovementioned, was proſecuted with ſuch ſeverity, that no leſs than 5000 perſons, who till then had been conſidered as free-men, were ſold for ſlaves. This piece of cruelty has been of great ſervice to the critics, as by means of it we know exactly the number of Athenian citizens, which at this time amounted to no more than 14,040 perſons, though Athens was now aiming at no leſs than erecting an univerſal monarchy.

105 Cruelty of Pericles.

106 Number of the Athenian citizens.

Six years after the concluſion of the peace between Athens and Sparta, a war broke out between the Samians and Mileſians about the city of Priene, ſeated under mount Mycale in Ionia. How this war came to affect the Athenians is not certainly known: but ſomehow or other, this republic was induced to take the part of the Mileſians; and the iſland of Samos was reduced by Pericles, who eſtabliſhed there a democracy, and left an Athenian garriſon. He was no ſooner gone, however, than the Samians, diſliking their new form of government, drove out the garriſon he had left; but Pericles quickly returning, beſieged and took their city, demoliſhed their walls, and fined them of the whole expence of the war; part of which he obliged them to pay down, and took hoſtages for the remainder. When Pericles returned, he procured himſelf to be appointed to pronounce the public oration in honour of thoſe who fell; which he did with ſuch eloquence, that when he came down from the pulpit the women gathered about him, took him by the hand, and crowned him with garlands.

107 Samos reduced by Pericles.

A little after this commenced the war between the Corcyrians and Corinthians, which by degrees brought the Athenians into thoſe engagements that proved the ruin of their ſtate. The cauſes of this war were the following. An inteſtine war breaking out in the little territory of Epidamnum, a city of Macedonia founded by the Corcyrians, one party called in to their aſſiſtance the Illyrians, and the other the Corcyrians. The latter neglecting the matter, Corinth was applied to, as the Corcyrians were a colony from that place. The Corinthians, partly out of pity to the Epidamnians, and partly out of ſpleen to the Corcyrians, ſent a very great fleet to the aſſiſtance of the former, by which means that party which had applied to Corinth was thoroughly eſtabliſhed. This being reſented by the Corcyrians, they ſent a fleet to Epidamnum to ſupport the exiles; and accordingly this fleet began to act offenſively on its entering the port, the chief commanders having inſtructions to propoſe terms of accommodation, to which the Corinthians would by no means agree. The next year the Corcyrians defeated at ſea the Corinthians and their allies, and took Epidamnum by ſtorm; after which they waſted the territories of the allies of the Corinthians, which greatly exaſperated the latter. At Corinth, therefore, they began to make great preparations for carrying on the war, and preſſed their confederates to do the ſame, that they might be in a condition to retrieve the honour they had loſt, and humble this ungrateful colony which had thus inſulted her mother-city.

108 War between the Corcyrians and Corinthians.

The Corcyrians were no ſooner acquainted with theſe proceedings, than they diſpatched ambaſſadors to Athens with their complaints; and theſe were quickly followed by others from Corinth on the ſame errand. At firſt the people of Athens inclined to favour the Corinthians; but they ſoon changed their minds, and took part with the Corcyrians: they contented themſelves, however, with entering into a defenſive alliance with that little ſtate, whereby they promiſed to aſſiſt each other, in caſe either party ſhould be attacked; and in conſequence of this treaty, they furniſhed the Corcyrians with ten galleys, under Lacedæmonius the ſon of Cimon, with whom were joined Diotenes and Proteus as colleagues.

109 Athens ſides with the Corcyrians.

As ſoon as the ſeaſon of the year permitted, the Corinthians ſailed for the coaſt of Corcyra with a fleet of 150 ſhips, under the command of Xenoclides aſſiſted by four other Corinthian admirals; each ſquadron of their allies being commanded by a chief of their own. The Corcyrian and Athenian fleet amounted to 120, but the Athenians had orders to give as little aſſiſtance as poſſible. The action was very briſk for ſome time: the Corcyrian right wing broke the left of the Corinthian fleet; and forcing ſome of the ſhips on ſhore, landed, pillaged their camp, and made a great number of them priſoners: on the other hand, the Corinthian ſhips in their right wing beat the Corcyrian ſhips there, they being but very faintly aſſiſted by the Athenians, till the latter were at laſt obliged to defend themſelves, which they did ſo well, that the Corinthians were glad to retire. The next day preparations were made on both ſides for another engagement; but 20 ſhips coming from Athens to the aſſiſtance of the Corcyrians, the Corinthians declined the combat.

110 Potidæa beſieged by the Athenians.

As ſoon as the Corcyrian war broke out, the Athenians ſent orders to the citizens of Potidæa to demoliſh a part of their wall, to ſend back the magiſtrates they had received from Corinth, and to give hoſtages for their own behaviour. Potidæa was a town in Macedonia,

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donia, founded by the Corinthians, but at that time in alliance with the Athenians. Perdiccas king of Macedon, who hated the Athenians, took this opportunity to perſuade the Potidæans to revolt. Accordingly they ſent ambaſſadors to Athens to intreat the revocation of theſe orders: but at the ſame time ſent deputies to Sparta, to join with the Corinthians and Megarians in their complaints againſt the Athenians. The Athenians upon this ſent a conſiderable fleet againſt Potidæa under the command of Calias, a nobleman of great courage. The Corinthians on their part diſpatched one Ariſteus with a conſiderable body of troops to the aſſiſtance of that city. An engagement following, the Athenians were victors, but with the loſs of their general. Phormio, who ſucceeded in the command, inveſted the city in form, and ſhut up its port with his fleet; but the Potidæans dreading to fall into the hands of the Athenians, made a moſt obſtinate defence, while in the mean time they warmly ſolicited the Corinthians to perform their promiſes, and engage the reſt of the ſtates of Peloponneſus in their quarrel.

111 The Spartans demand reparation for the injuries offered to the ſtates of Greece.

The Lacedemonians having heard what the Corinthians, and other little ſtates of Greece had to ſay againſt the Athenians, ſent ambaſſadors to the latter, demanding reparation for the injuries, with orders, in caſe of a refuſal to declare war. The terms demanded were, in the firſt place the expulſion of thoſe Athenians who were allied to the family of Megacles ſo often mentioned. This article was on account of Pericles; for he was the ſon of Xanthippus the Athenian commander at Mycale, by Agariſte niece to the famous Clyſthenes, who corrupted the prieſteſs of Apollo in order to procure the expulſion of the Piſiſtratidæ. They next inſiſted that the ſiege of Potidæa ſhould be raiſed; thirdly, that the inhabitants of Ægina ſhould be left free; and, laſtly, that a decree made againſt the Megarians, whereby they were forbid the ports and markets of Athens, ſhould be revoked, and all the Grecian ſtates under the dominion of Athens ſet at liberty.

112 Their terms rejected by advice of Pericles.

Theſe terms the Athenians were perſuaded by Pericles to reject. The arguments uſed by him were in ſubſtance as follows: That whatever the Lacedemonians migh pretend as to the juſtice of the complaints of the allies, the true ground of this reſentment was the proſperity of the Athenian republic, which the Spartans always hated, and now ſought an opportunity of humbling; that it muſt be owing to the Athenians themſelves if this deſign ſucceeded, becauſe for many reaſons Athens was better able to engage in a long and expenſive war than the Peloponneſians. He then laid before the people an exact account of their circumſtances; putting them in mind, that the treaſure brought from Delos amounted to 10,000 talents; and that tho' 4000 of theſe had been expended on the ſtately gate of their citadel, yet that 6000 were ſtill in hand; that they were alſo intitled to the ſubſidies paid by the confederate ſtates; that the ſtatues of their gods, the Perſian ſpoils, &c. were worth immenſe ſums; that private men were arrived at vaſt fortunes; and that, conſidering their trade by ſea, they had a certain annual increaſe of wealth; that they had on foot an army of 12,000 men, and in their colonies and garriſons 17000; that their fleet conſiſted of 300 ſail; whereas the Peloponneſians had no ſuch advantages. For theſe reaſons he propoſed as the moſt feaſible, and likewiſe the moſt equitable ſatisfaction that could be given, that they would reverſe their decree againſt Megara, if the Lacedemonians would allow free egreſs and regreſs in their city to the Athenians and their allies; that they would leave all thoſe ſtates free who were free at the making of the laſt peace with Sparta, provided the Spartans would alſo leave all ſtates free who were under their dominion; and that future diſputes ſhould be ſubmitted to arbitration. In caſe theſe offers ſhould be rejected, he adviſed them to hazard a war; telling them, that they ſhould not think they ran that hazard for a trifle, or retain a ſcruple in their minds as if a ſmall matter moved them to it, becauſe on this ſmall matter depended their ſafety, and the reputation of their conſtancy and reſolution; whereas, if they yielded in this, the next demand of the Lacedemonians would be of a higher nature; for having once diſcovered that the Athenians were ſubject to fear, they would thence conclude that nothing could be denied to Sparta, whereas a ſtiff denial in this caſe would teach them to treat Athens for the future on terms of equality. He enforced theſe reaſons by ſhowing that their anceſtors had always acted on the like principles, and in all caſes preferred their glory to their eaſe, and their liberty to their poſſeſſions.

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This was the origin of the Peloponneſian war, which makes ſo great a figure in ancient hiſtory. The immediate preliminary to general hoſtilities was an attempt of the Thebans to ſurpriſe Platæa. With this view they ſent Eurymachus with 300 Thebans to aſſiſt ſuch of the Platæans as they had drawn over to their intereſt, in making themſelves maſters of the place. In this deſign they ſucceeded very well at firſt, the Platæans who had promiſed to open the gates keeping their words exactly, ſo that they were inſtantly in poſſeſſion of the city. The other party, however, perceiving how ſmall a number they had to contend with, unanimouſly roſe upon them, killing a great many, and forced the reſt to ſurrender themſelves priſoners of war. Another party came from Thebes to aſſiſt their countrymen; but they arrived too late: the Platæans, however, foreſeeing that they would waſte their country, promiſed to releaſe their priſoners if they would forbear to ſpoil their lands. On this the Thebans withdrew; and the Platæans cruelly put to death all their priſoners, to the number of 180, with Eurymachus their chief, alledging that they had not promiſed their releaſe but in caſe of peace. The Athenians, as ſoon as they had notice of this attempt of the Thebans, cauſed all the Bœotians in their territory to be arreſted; and when they underſtood how the Platæans had delivered themſelves, they ſent a great convoy of proviſions to that city, and a numerous body of troops to eſcort their wives and children to Athens.

113 Attempt of the Thebans on Platæa.

114 They are maſſacred.

115 Account of the allies on both ſides.

Both parties now prepared in earneſt for war, both ſent ambaſſadors to the Perſians, and both ſought to rouſe their allies. Moſt of the Greek ſtates inclined to favour the Spartans, becauſe they acted on this occaſion as the deliverers of Greece, and becauſe they either had been, or feared that they would be, oppreſſed by the Athenians. With the Spartans joined all the Peloponneſians, except the Argives and part of the Achæans;

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chæans; without Peloponneſus, the Megarians, Phocians, Locrians, Bœotians, Ambraciots, Leucadians, and Anactorians, declared themſelves on their ſide. On the other hand, the Chians, Leſbians, Platæans, Meſſenians, Acarnanians, Corcyrians, Zacynthians, Carians, Dorians, Thracians, moſt part of the iſlands, and all the Cyclades excepting Melos and Thera, with Eubœa and Samos, joined the Athenians.

116 First year of the war. The Peloponneſian war commenced 431 years before Chriſt. The Lacedemonian army was aſſembled at the Iſthmus, and conſiſted of no leſs than 60,000 men; but before Archidamus king of Sparta, who commanded in chief, would enter Attica, he diſpatched a herald to Athens. The herald was ſent back without any anſwer, by which all hopes of peace were cut off. As Archidamus was a friend to Pericles, the latter apprehended that he might forbear plundering his eſtates. With this he immediately acquainted the people; telling them at the ſame time, that in ſuch a caſe he made a preſent of his lands to the public. He then adviſed the citizens to take no care of defending their country-ſeats, but to attend only to the city, buſy themſelves in the equipping of ſhips, and ſettle a thorough reſolution not to be intimidated with the firſt evils of war. This propoſal the Athenians readily complied with, and appointed Pericles commander in chief, with nine more generals to aſſiſt him.

The firſt year; the Spartan army committed great ravages in Attica, Pericles having no force capable of oppoſing it, and refuſing to engage on diſadvantageous terms, notwithſtanding prodigious clamours were raiſed againſt him by his countrymen. The allies, however, had no great reaſon to boaſt of the advantages they gained this year: an Athenian fleet ravaged the coaſts of Peloponneſus; another infeſted the Locrians, drove out the inhabitants of Ægina, and repeopled the iſland from Athens. They likewiſe reduced Cephalenia, and ſome towns in Acarnania and Leucas which had declared for the Lacedemonians; and in the autumn, when the Peloponneſians were retired, Pericles entering the Megarian territory, did all the miſchief that could be expected from a provoked enemy.

117 Second year. A dreadful plague at Athens. The ſpring of the ſecond year was very fatal to Athens by a dreadful plague which deſtroyed great numbers of the citizens, while the Peloponneſians under Archidamus waſted every thing abroad. In the midſt of theſe diſtreſſes, however, Pericles retained his courage, and would ſuffer none of his countrymen to ſtir without the city, either to eſcape the plague or infeſt the enemy. He cauſed a great fleet to be equipped, on board which he embarked 4000 foot and 300 horſe, with which he ſailed to Epidaurus. Upon this the enemy withdrew their forces out of Attica; but Pericles was able to do no great matter on account of the plague, which made ſo great havock among his men,

118 Athenians ſue for peace. that he brought back to Athens only 1500 of the 4000 he carried out. By this misfortune the Athenians were thrown into deſpair; they immediately ſued for peace, which the Spartans were now too proud to grant; then turning their rage upon Pericles, they diſmiſſed and fined him. Soon after, Pericles's children and almoſt all his relations died of the plague; ſo that this great ſtateſman was overwhelmed with melancholy, and for ſome time ſhut himſelf up from public view: at laſt, through the perſuaſion of Alcibiades and ſome others, he ſhowed himſelf to the people. They received him with acclamations, and at his requeſt repealed the unjuſt law he had made, whereby all the Athenians of the half blood were diſfranchiſed, and then reinſtated him in all his former honours. Hereupon he inrolled the only ſon he had left, who before had been counted a baſtard on account of his mother being a Mileſian.

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119 Pericles requeſts the repeal of his law.

This year alſo the iſland of Zacynthus was waſted by the Peloponneſians; and the city of Potidæa ſubmitted to the Athenians, after the inhabitants had been driven to ſuch extremity as to feed upon human fleſh. The Athenians permitted the men to depart with one garment, and the women with two; after which, the town was repeopled by a colony from Athens.

120 Third year. Pericles dies. The third year of the Peloponneſian war was remarkable for the death of the great Pericles, who was taken off by the plague. Platæa was alſo beſieged by Archidamus; but without ſucceſs, even though the greateſt part of it was ſet on fire, the Platæans reſolving to ſubmit to every kind of miſery rather than abandon the Athenian cauſe. In the end, therefore, the king of Sparta was obliged to turn the ſiege into a blockade; and having thrown up an entrenchment fortified with a deep ditch, he left a ſufficient number of men to guard his lines, and then returned back to Peloponneſus.

121 Platæa beſieged.

122 Fourth year. Deſperate attempt of the Platæans. The following ſummer the Peloponneſians under the command of Archidamus invaded Attica, where they waſted every thing with fire and ſword; at the ſame time the whole iſland of Leſbos, except the diſtrict of Methymna, revolted from the Athenians, who hereupon inveſted the city of Mitylene. All this time the city of Platæa was blocked up by the Peloponneſians; and its inhabitants being now greatly diſtreſſed for want of proviſions, the garriſon, conſiſting of 400 natives and 80 Athenians, came to the deſperate reſolution of forcing a paſſage through the enemy's lines. When they came to attempt this, however, many of them were intimidated: but 300 perſiſted in their reſolution; and of theſe 212 got ſafe through and marched to Athens, but the reſt were compelled to retire.

123 Fifth year. Mitylene, &c. taken by the Athenians. In the beginning of the fifth year, the Peloponneſians ſent 40 ſhips to the relief of Mitylene; but without effect, for the place had ſurrendered before the fleet could come to its aſſiſtance. Paches, the Athenian commander, likewiſe chaſed away the Peloponneſian fleet upon its arrival; and returning to Leſbos ſent the Lacedemonian miniſter, whom he found in Mitylene, together with a deputation, to Athens. On their arrival the Lacedemonian was immediately put to death; and in a general aſſembly of the people, it was reſolved, that all the Mitylenians who had arrived at man's eſtate ſhould be put to death, and the women and children ſold for ſlaves. The next day, however, this cruel decree was reverſed, and a galley ſent with all expedition to countermand theſe bloody orders. This laſt veſſel, however, could not get before the other: but Paches, being a man of great humanity, had taken a day to conſider on the orders he had received; during which time the laſt mentioned galley arrived; in conſequence of which, only about 1000 of the moſt forward rebels were put to death; the walls of the city were alſo demoliſhed, their ſhips taken away, and their lands divided among the Athenians, who let them again to their old maſters at very high rents. The ſame ſummer

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mer the Athenians ſeized the iſland of Minoas, lying over againſt the territory of Megara: and likewiſe the port Niſæa, which laſt they fortified, and it proved afterwards a place of the utmoſt importance to them.

124 Platæa taken and razed.

At this time alſo the Platæans, driven to the laſt extremity, ſurrendered to the Lacedemonians, by whom they were, to the number of 208, including 25 Athenians, put to death, and their women ſold for ſlaves. Their city was ſoon after razed by their implacable enemies the Thebans, who left only an inn to ſhow where it ſtood. The fame of Platæa, however, induced Alexander the Great afterwards to rebuild it.

125 Sedition of Corcyra.

In this year happened the famous ſedition of Corcyra, whence other ſeditions, when their effects rendered them terrible, have been called *Corcyrian*. It hath been already obſerved, that the war between the Corcyrians and Corinthians brought on the general war throughout Peloponneſus. A great number of Corcyrians were in the beginning of this war carried away priſoners into Peloponneſus, where the chief of them were very well treated, but the reſt ſold for ſlaves. The reaſon of this conduct of the Corinthians was a deſign they had formed of engaging theſe Corcyrians to influence their countrymen to ſide with them and their allies. With this view they treated them with all imaginable lenity and tenderneſs, inſtilling into them by degrees an hatred of democratic government; after which they were told, that they might obtain their liberty upon condition of uſing all their influence at home in favour of the allies, and to the prejudice of Athens. This the Corcyrians readily promiſed, and endeavoured to perform. At firſt, thoſe who were for an ariſtocracy prevailed, and murdered all thoſe of the oppoſite party that fell into their hands, in which they were aſſiſted by a fleet of Peloponneſians: but the Athenians ſending firſt one fleet and then another to the aſſiſtance of the diſtreſſed party, the Peloponneſians were forced to withdraw; after which, the democratic party ſufficiently revenged themſelves, and deſtroyed their antagoniſts without mercy. The worſt of all was, that, this example once ſet, the ſeveral ſtates of Greece felt in their turns the like commotions, which were always heightened by agents from Sparta and Athens; the former endeavouring to ſettle ariſtocracy, and the latter democracy, wherever they came.

126 Athenians engage in a war with Sicily.

While the Athenians were thus engaged in a war wherein they were already overmatched, they fooliſhly engaged in a new one, which in the end proved more fatal than all the reſt. The inhabitants, of Sicily were ſplit into two factions; the one called the *Doric*, at the head of which was the city of Syracuſe; the other the *Ionic*, which owned the Leontines for their chiefs: the latter perceiving themſelves too weak without foreign aid, ſent one Georgias, a celebrated orator, to apply to Athens for relief; and he by his fine ſpeeches ſo captivated the giddy and inconſtant Athenians, that they ran headlong into a war which they were unable to maintain, while engaged with all the Peloponneſians. Enticed by this new proſpect, therefore, and graſping at the conqueſt of Sicily, as well as of all Greece, they ſent a fleet to the aſſiſtance of the Leontines, under the command of Lachetes and Chabrias; and they were no ſooner ſailed, than another fleet for the ſame purpoſe was begun to be fitted out. All this time the plague continued to rage with great violence at Athens, cutting off this year 4000 citizens, beſides a much greater number of the meaner ſort of people.

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127 Sixth year.

The ſixth year of the Peloponneſian war was remarkable for no great exploit: Agis the ſon of Archidamus, king of Sparta, aſſembled an army in order to invade Attica, but was prevented from ſo doing by many great earthquakes which happened throughout Greece. The next year, however, he entered Attica with his army, while the Athenians on their part ſent a fleet under the command of Demoſthenes, to infeſt the coaſts of Peloponneſus. As this fleet paſſed by Laconia, the commander took notice that the promontory of Pylus, which was joined to the continent by a narrow neck of land, had before it a barren iſland about two miles in circumference, in which, however, there was a good and ſafe port, all winds being kept off by the headland, or by the iſle. Theſe advantages made him apprehend, that a garriſon left here would give the Peloponneſians ſo much trouble, that they would find it more adviſeable to protect their own country than to invade that of their neighbours. Accordingly, having raiſed a ſtrong fortification, he himſelf with five ſhips ſtaid to defend it, while the reſt of the fleet proceeded on their intended expedition. On the news of this event, the Peloponneſian army immediately returned to beſiege Pylus. When they arrived before the place they took poſſeſſion of the harbour, and then cauſed a choſen body of Spartans to take poſſeſſion of the iſland of Sphacteria, after which they attacked the fort with great vigour. Demoſthenes and his garriſon defended themſelves with great valour; and an Athenian fleet arriving very ſeaſonably, offered battle to the Peloponneſian fleet. This being refuſed, the Athenians boldly ſailed into the harbour, broke and ſunk moſt of the veſſels therein, after which they beſieged the Spartans in Sphacteria. The Peloponneſians now began to treat with their enemies, and a truce was concluded during the time that negociations were carried on at Athens. One of the articles of this truce was, that the Peloponneſians ſhould deliver up all their ſhips, on condition of having them punctually returned in caſe the treaty did not take effect. The Athenians having heard the Spartan ambaſſadors, were inclined to put an end to this deſtructive war: but Cleon, one of their orators, a warm and obſtinate man, perſuaded his countrymen to inſiſt on very unreaſonable terms; upon which the ambaſſadors returned, and by ſo doing put an end to the truce. The Peloponneſians then demanded their veſſels; but the Athenians refuſed to deliver them, under pretence of their having broke the truce.

128 Seventh year. Pylus fortified by the Athenians.

129 Beſieged.

130 Spartan fleet deſtroyed.

131 Treachery of the Athenians.

Hoſtilities being thus recommenced on both ſides, the Lacedemonians attacked the Athenians at Pylus, while the latter attacked the Spartans at Sphacteria. The Spartans, though but an handful of men and under every imaginable diſcouragement, behaved with ſuch bravery, that the ſiege proceeded very ſlowly, ſo that the people of Athens became very uneaſy. They began then to wiſh they had embraced the offers of the Spartans, and to rail vehemently againſt Cleon, who, to excuſe himſelf, ſaid, it would be eaſy for the general of the forces they were at that time ſending, to attack the Spartans in the iſle, and reduce them at once. Nicias, who had been appointed to this command, replied, that if Cleon believed he could do ſuch great things, he

132 They attack Sphacteria.

133 Cleon the orator appointed general.

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he would do well to go thither in perſon: the latter, imagining this only meant to try him, ſaid he was ready to go with all his heart; whereby Nicias catched him, and declared that he had relinquiſhed his charge. Cleon thereupon ſaid, that he was no general: but Nicias told him that he might become one; and the people, pleaſed with the controverſy, held the orator to his word. Cleon then advancing, told them he was ſo little afraid of the enemy, that, with a very inconſiderable force, he would undertake, in conjunction with thoſe already at Pylus, to bring to Athens the Spartans who gave them ſo much trouble in 20 days. The people laughed at theſe promiſes: however, they furniſhed him with the troops he deſired; and to their ſurpriſe, Cleon brought the Spartans priſoners to Athens within the time appointed.

134 He takes the place.

135 End of the Corcyrian ſedition.

This ſummer, likewiſe, an Athenian fleet was ſent to Sicily, with inſtructions to put in at Corcyra, and aſſiſt the government againſt the Lacedemonian faction which ſtill ſubſiſted in that iſland. This they effectually performed; for by their means the exiles fell into the hands of the other party: theſe they impriſoned; and then drew them out by 20 at a time, to ſuffer death, which was inflicted with all the circumſtances of cruelty that party-rage could ſuggeſt. When only 60 remained, they intreated the Athenians to put them to death, and not to deliver them up to their countrymen: but upon this the Corcyrians ſurrounded the place where they were confined, endeavouring to bury them under their darts; upon which the unhappy captives all put an end to their own lives.

136 Eighth year. Succeſs of the Athenians.

In the eighth year Nicias reduced the iſle of Cythera on the coaſt of Laconia; as likewiſe Thyræa, on the confines of that country. The latter had been given to the Æginetans when expelled from their own country by the Athenians: and they were now condemned to death, as inveterate enemies of the Athenian ſtate and nation.—In Sicily, one Hermocrates of Syracuſe perſuaded all the inhabitants of the iſland to adjuſt their differences among themſelves; upon which the Athenian generals returned home, and for ſo doing two of them were baniſhed, and the third ſentenced to pay a heavy fine.

The Athenians next laid ſiege to Megara under the conduct of Hippocrates and Demoſthenes; but Braſidas a Spartan general coming to its relief, a battle enſued, by which, though neither party got the better,

137 Spartan party prevails in Megara.

the Lacedemonian faction prevailed in Megara, and many who favoured the Athenians were forced to withdraw. After this, ſuch as had been baniſhed for adhering to the Lacedemonians were allowed to return, on their taking an oath to forget what was paſt, and attempt nothing that might diſturb their country. As ſoon as they were ſettled, however, they forgot their oath; and cauſing 100 of thoſe who were moſt obnoxious to be apprehended, forced the people to condemn them to death. They then changed the whole form of government, introduced an oligarchy, and poſſeſſed themſelves of the ſupreme power.

138 Athenians loſe their power in Bœotia.

In Bœotia ſome commotions were raiſed in favour of the Athenians; but their generals Hippocrates and Demoſthenes being defeated by the oppoſite party, all hopes ceaſed of the Athenian power being eſtabliſhed in Bœotia. In the mean time Braſidas reduced the city of Amphipolis, which greatly alarmed the Athenians, who thereupon ſent new ſupplies of men, money, and ſhips to the Macedonian coaſt; but all their care could not prevent a great deſertion from their intereſt in thoſe parts, where the valour and conduct of Braſidas carried all before him.

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139 Ninth year. A truce concluded and broken.

In the ninth year, the Spartans made new propoſals of peace, which the Athenians were now more inclined to accept than formerly; and finding their affairs very much unſettled by the loſs of Amphipolis, a truce for a year was quickly agreed on, while negociations were in the mean time carrying on for a general peace. This pacific ſcheme, however, was very ſoon overthrown by the following accident in Thrace. The city of Scione, and that of Menda, revolted to Braſidas; who, knowing nothing of the truce, ſought to draw over Potidæa alſo. The Athenians, pretending that Scione revolted two days after the truce was concluded, made heavy complaints, aſſerting that this was a breach of the truce, and that both it and Menda ſhould be reſtored to them. This not being effected by negociations, an army was ſent againſt the two cities, by which Menda was reduced; but Scione making an obſtinate defence, the ſiege was turned into a blockade.

140 Tenth year Cleon defeated and killed by Braſidas.

In the tenth year, Braſidas made an attempt upon Potidæa; which having failed, the Athenians began to recover ſome courage. The truce expiring on the day of the Pythian games, Cleon perſuaded the Athenians to ſend an army into Thrace under his command. It conſiſted of 1200 foot and 300 horſe, all Athenian citizens, who embarked on board 30 galleys. Braſidas had an army much inferior; but obſerving that the Athenian general was become careleſs, and neglected diſcipline, he attacked him. In this engagement Cleon was killed, and the Athenians defeated with the loſs of 600 men, while the Spartans loſt only ſeven; but among theſe was their great commander Braſidas, whoſe death affected them almoſt as much as the loſs of their army did the Athenians.

141 A fifty years peace

As the death of Cleon deprived the Athenians of one of their beſt ſpeakers, and one who had been very induſtrious in promoting the war, they were now much more diſpoſed than formerly to hearken to terms of accommodation. Amongſt the Spartans, too, there was a party, at the head of whom was Pliſtonax their king, who earneſtly wiſhed for peace; and as Nicias laboured no leſs aſſiduouſly at Athens to bring about this deſirable event, a peace was at laſt concluded for fifty years between the two nations. The conditions were, that a reſtitution of places and priſoners ſhould be made on both ſides; excepting that Niſœa ſhould remain to the Athenians, who had taken it from the Megarians; and that Platæa ſhould continue with the Thebans, becauſe they abſolutely would not give it up. The Bœotians, Corinthians, and Megarians, refuſed to be included in this peace: but the reſt of the allies yielded to it; and it was accordingly ratified, receiving the name of the *Nician* peace, from Nicias who had ſo vigorouſly promoted it.

142 New diſcontents.

By this means, however, tranquillity was far from being reſtored. Such of the ſtates of Peloponneſus as were diſſatisfied, began immediately to league among themſelves, and to ſet on foot a new confederacy, the head of which was to be the ſtate of Argos. The Lacedemonians, too, found it impoſſible to perform exactly the articles of agreement; the city of Amphipolis

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in particular, abſolutely refuſed to return under the Athenian government; for which reaſon the Athenians refuſed to evacuate Pylus. In the winter, new negociations were entered into on all ſides, but nothing determined, and univerſal murmuring and diſcontent took place. Theſe diſcontents were not a little heightened by Alcibiades, who now began to rival Nicias, and, perceiving the Lacedemonians made their court moſtly to his rival, took all opportunities to incenſe his countrymen againſt that nation. Nicias, on the other hand, who wiſhed for nothing ſo much as a peace, uſed all his endeavours to bring about a reconciliation. The artifices of Alcibiades, however, added to the turbulent and haughty diſpoſition of both nations, rendered this impoſſible; ſo that though Nicias went on purpoſe to Sparta, he returned without doing any thing.

143 Heightened by Alcibiades.

144 His meaſures for the ſafety of Attica.

Alcibiades having thus diſpoſed every thing according to his wiſhes, and a war being inevitable, he began to take the moſt prudent methods for preſerving his country in ſafety. With this view he entered into a league for 100 years with the Argives, which he hoped would keep the war at a diſtance: he next paſſed over into the territories of Argos, at the head of a conſiderable army; and laboured, both at that city and at Patræ, to perſuade the people to build walls to the ſea, ſo that they might the more eaſily receive aſſiſtance from the Athenians. But though great preparations for war were now made, nothing was undertaken this year; only the Argives thought to have made themſelves maſters of Epidaurus, but were hindered by the Lacedemonians putting a garriſon into it.

145 Fourteenth year. War renewed.

The next year, (the 14th after the Peloponneſian war was firſt begun) a Spartan army, under the command of Agis, entered the territory of Argos where the confederate army lay; but juſt as the engagement was about to begin, a truce was ſuddenly concluded by two of the Argive generals and the king of Sparta. With this neither party was pleaſed, and both the king and generals were very ill treated by their citizens. On the arrival of ſome freſh troops from Athens, therefore, the Argives immediately broke the truce: but the allied army was ſoon after defeated with great ſlaughter by Agis; notwithſtanding which, however, the Eleans and Athenians inveſted Epidaurus. In the winter, a ſtrong party in Argos joined the Lacedemonians; in conſequence of which that city renounced her alliance with Athens, and concluded one with Sparta for 50 years. In compliment to their new allies, alſo, the Argives aboliſhed democracy in their city, eſtabliſhing an ariſtocracy in its place, and aſſiſted the Lacedemonians with a conſiderable body of troops to force the Sicyonians to do the ſame.

146 Athenians, &c. defeated at Mantinea.

147 Fifteenth year.

In the beginning of the 15th year, the Argives, with a levity ſeemingly natural to all the Greeks, renounced their alliance with Sparta, aboliſhed ariſtocracy, drove all the Lacedemonians out of the city, and renewed their league with Athens. The Athenians, in the mean time, being convinced of the treachery of Perdiccas king of Macedon, renounced their alliance with him, and declared war againſt him.

148 Sixteenth year. Melos reduced by the Athenians.

Next year Alcibiades terminated the diſputes in the city of Argos, by the baniſhment of the Spartan faction; after which he ſailed to the iſland of Melos, whoſe inhabitants had acted with the greateſt inveteracy againſt his countrymen: perceiving, however, that the reduction of the iſland would be a work of time, he left a conſiderable body of forces there, and returned to Athens. In his abſence the capital of Melos ſurrendered at diſcretion, and the inhabitants were treated with the utmoſt cruelty; all the men capable of bearing arms being ſlaughtered, and the women and children carried into captivity.

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149 Seventeenth year. Athenian army in Sicily loſt, and Alcibiades flies to Sparta.

In the beginning of the 17th year, Nicias was appointed commander of an expedition againſt the Syracuſans, along with Alcibiades and Lamachus as colleagues. But while the neceſſary preparations were making, all things were thrown into confuſion by the defacing of the Hermæ, or ſtatues of Mercury, of which there was a great number in the city. The authors of this ſacrilege could by no means be diſcovered, though rewards were offered for this purpoſe; at laſt the ſuſpicion fell upon Alcibiades; and for this weighty reaſon he was commanded to return from Sicily to take his trial. Alcibiades, however, knew the temper of his countrymen too well to truſt himſelf to their mercy; and therefore, inſtead of returning to Athens, he fled immediately to Sparta, where he met with a gracious reception; while the infatuated Athenians were ſeverely puniſhed by the loſs of their armies, generals, and fleet, in Sicily, which the ſuperior abilities of Alcibiades would in all probability have prevented.

150 Nineteenth and twentieth years, &c.

The 19th and 20th years of the war were ſpent by the Athenians in equipping a new fleet in order to repair their vaſt loſſes: but Alcibiades hurt their intereſts very much, by perſuading Tiſſaphernes the Perſian to league with the Spartans againſt them; at the ſame time he perſuaded ſeveral of the Ionian ſtates to revolt from Athens, but they were in a ſhort time obliged again to ſubmit. Notwithſtanding all theſe ſervices, however, Alcibiades had rendered himſelf ſo hateful to Agis by debauching his wife, that he ſoon found himſelf obliged to fly to the Perſians, where Tiſſaphernes gave him a very favourable reception, and profited much by his advice, which was to let the Greeks weaken one another by their mutual wars, and that the Perſians ought never to ſee one ſtate totally deſtroyed, but always to ſupport the weaker party.

151 Alcibiades flies to Perſia.

152 Propoſes the abolition of democracy at Athens.

When Tiſſaphernes had acquieſced with theſe counſels, Alcibiades privately wrote to ſome of the officers in the Athenian army at Samos, that he had been treating with the Perſians in behalf of his countrymen, but did not chooſe to return till the democracy ſhould be aboliſhed; and to incline the citizens to comply with this meaſure, he told them that the Perſian king diſliked a democracy, but would immediately aſſiſt them if that was aboliſhed, and an oligarchy erected in its ſtead.

On the arrival of Piſander and other deputies from the army, with the propoſals of Alcibiades, the Athenians without heſitation reſolved to overturn that democracy which they had all along ſo ſtrenuouſly defended. The iſſue of their preſent debates was, that Piſander with ten deputies ſhould return to Alcibiades, in order to know on what terms the king of Perſia would make an alliance with them; but that cunning Athenian having perceived that Tiſſaphernes was by no means diſpoſed to aſſiſt the Athenians on account of their having been lately ſucceſsful, he ſet up ſuch high demands in the king of Perſia's name, that the Athenians of themſelves broke off the treaty, and

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and thus Alcibiades preſerved the friendſhip of both parties.

153 New form of government eſtabliſhed.

Piſander having engaged the army at Samos in his ſcheme of overturning democracy, that form of government was aboliſhed firſt in the cities ſubject to Athens, and laſtly in the capital itſelf. Piſander's new ſcheme was, That the old form of government ſhould be totally diſſolved: that five prytanes ſhould be elected: that theſe five ſhould chooſe 100; and that each of the hundred ſhould chooſe three: that the 400 thus elected ſhould become a ſenate with full power; but ſhould occaſionally conſult with 5000 of the moſt wealthy citizens, who ſhould thenceforward be eſteemed only *the people;* and that no authority ſhould remain with the loweſt claſs. Though the people were not very fond of this change, thoſe who conducted it, being men of great parts found means to eſtabliſh it by force; for when the people were gone out of the city to their ordinary employments, the 400, having each a dagger concealed under his veſt, attended by a guard of 120 men, entered the ſenate-houſe, diſſolved the old ſenate, and without ceremony turned them out; after which the commons, not knowing whom to ſubmit to, or to whom to apply, made no oppoſition.

The firſt ſtep of the new governors was to deſtroy all their enemies; who, however, were not very numerous, ſo that little blood was ſhed. They next ſent ambaſſadors to Agis to ſue for peace; but he, taking for granted that the Athenians would never defend an oligarchy, gave no anſwer to the ambaſſadors, but immediately marched towards the capital with a deſign to attack it. On his arrival, however, he was quickly convinced of his miſtake, being repulſed with loſs, and obliged to retire to his old poſt.

154 The army declare for democracy, and recall Alcibiades.

In the mean time the Athenian army declared again for a democracy, and having recalled Alcibiades, inveſted him with full power, and inſiſted on his immediate return to Athens to reſtore the ancient government. This meaſure he refuſed to comply with, and perſuaded them to ſtay where they were, in order to ſave Ionia: he alſo prevailed on them to allow ſome deputies, who had been ſent from the new governors of Athens, to come and deliver their meſſage. To theſe deputies Alcibiades replied, that they ſhould immediately return to Athens, and acquaint the 400, that they were commanded immediately to reſign their power and reſtore the ſenate; but that the 5000 might retain theirs, provided they uſed it with moderation.

155 Great confuſion at Athens.

By this anſwer the city was thrown into the utmoſt confuſion; but the new government party prevailing, ambaſſadors were diſpatched to Sparta with orders to procure peace on any terms. This, however, was not to be effected; and Phrynicus, the head of the embaſſy, and likewiſe of the new government party, was murdered on his return. After his death, Theramenes the head of the other party, ſeized the chiefs of the 400; upon which a tumult enſued that had almoſt proved fatal to the city itſelf. The mob, however, being at laſt diſperſed, the 400 aſſembled, though in great fear, and ſent deputies to the people, promiſing to ſet all things to rights. In conſequence of this deputation, a day was appointed for convoking a general aſſembly, and ſettling the ſtate; but when that day came, news was brought that the Lacedemonian fleet appeared in view, and ſteered directly for Salamis. Thus all was again thrown into confuſion; for the people, inſtead of deliberating on the ſubject propoſed, ran in crowds down to the port, and perceiving the Spartans made towards Eubœa, a fleet of 36 ſhips was immediately diſpatched under the command of Thymochares, to engage the enemy. This fleet was utterly defeated, 22 of the Athenian ſhips being taken, and moſt of the others ſunk or diſabled; but what was worſe, this defeat was followed by the revolt of all the country of Eubœa except Orcus.

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156 Athenian fleet deſtroyed by the Spartans.

When theſe diſmal tidings arrived at Athens, every thing was given up for loſt; and had the Lacedemonians taken this opportunity of attacking the city, they had undoubtedly ſucceeded, and thus put an end to the war: but being at all times ſlow, eſpecially in naval affairs, they gave the Athenians time to equip a new fleet, and to retrieve their affairs. One good effect of this diſaſter, however, was the putting an end for a time to the internal diſſenſions of this turbulent people; inſomuch that Thucydides the hiſtorian is of opinion, that the republic never enjoyed ſo much quiet as at this time.

157 Exploits of Alcibiades.

Alcibiades now ſhowed his abilities and inclination to ſerve his country in an eminent manner. By his intrigues he ſo effectually embroiled the Perſians and Peloponneſians with each other, that neither party knew whom to truſt. Thraſybulus, with 55 ſhips, gained a victory over the Peloponneſian fleet conſiſting of 73: after which he took 8 galleys coming from Byzantium; which city had revolted from the Athenians, but was ſoon after taken, and the inhabitants ſeverely fined. The fleet being afterwards joined by Alcibiades, nine more of the Peloponneſian galleys were taken, the Halicarnaſſians were conſtrained to pay a large ſum of money, and Cos was ſtrongly fortified; which tranſactions ended the 21ſt year of the Peloponneſian war.

In the ſucceeding years of this famous war, the Athenians had at firſt great advantages. Thraſybulus gained a ſignal victory at ſea; and Alcibiades gained two victories, one by ſea and another by land, in one day, took the whole Peloponneſian fleet, and more ſpoil than his men could carry away. The Spartans were now humbled in their turn, and ſued for peace; but the Athenians were ſo intoxicated with their ſucceſs, that they ſent back the ambaſſadors without an anſwer; which they ſoon had ſufficient reaſon to repent of. The beginning of the Athenians misfortunes was the taking of Pylus by the Spartans. The Athenians had ſent a fleet under the command of one Anytus to its defence: but he was driven back by contrary winds; upon which he was condemned to death, becauſe he could not cauſe the wind blow from what quarter he pleaſed: this ſentence, however, was remitted on his paying a vaſt ſum of money. This misfortune was quickly followed by another. The Megarians ſurpriſed Niſæa; which enraged the Athenians ſo much, that they immediately ſent an army into that country, who defeated the Megarians who oppoſed them, with great ſlaughter, and committed horrid devaſtations.

158 The Spartans ſue for peace.

159 They take Pylus.

Theſe misfortunes as yet, however, were overbalanced by the great actions of Alcibiades, Thraſybulus, and

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and Theramenes. When Alcibiades returned, he brought with him a fleet of 200 ſhips, and ſuch a load of ſpoils as had never been ſeen in Athens ſince the concluſion of the Perſian war. The people left their city deſtitute, that they might crowd to the port, to behold Alcibiades as he landed; old and young bleſſed him as he paſſed; and the next day when he made a harangue to the aſſembly, they directed the record of his baniſhment to be thrown into the ſea, abſolved him from the curſes he lay under, and created him general with full power. Nor did he ſeem inclined to indulge himſelf in eaſe, but ſoon put to ſea again with a fleet of 100 ſhips. He had not been long gone, however, before all this was forgot. Alcibiades ſailed to the Helleſpont with part of his fleet, leaving the reſt under the command of Antiochus his pilot, but with ſtrict orders to attempt nothing before his return. This command the pilot paid no regard to, but provoked Lyſander the Lacedemonian admiral to an engagement, and in conſequence of his temerity was defeated with the loſs of 15 ſhips, himſelf being killed in the engagement. On the news of this defeat Alcibiades returned, and endeavoured to provoke the Lacedemonians to a ſecond battle: but this Lyſander prudently declined; and in the mean time the Athenians, with unparalleled ingratitude and inconſtancy, deprived Alcibiades of his command, naming ten new generals in his room.

160 Alcibiades enters Athens in triumph.

161 He is diſgraced.

162 The Athenians gain a great victory and put ſix of their generals to death.

This was the laſt ſtep the Athenians had to take for perfecting their ruin. Conon, who ſucceeded to the command, was defeated by Callicratidas Lyſander's ſucceſſor; but being afterwards ſtrongly reinforced, the Lacedemonians were entirely defeated with the loſs of 77 ſhips. Such a victory might at this time have inſpired the Athenians with ſome kind of gratitude towards the generals who gained it: but inſtead of this, on pretence of their not having aſſiſted the wounded during the engagement, eight of them were recalled; two were wiſe enough not to return; and the ſix who truſted to the juſtice of their country were all put to death.

163 They are utterly defeated by Lyſander;

The next year Lyſander was appointed commander of what fleet the Peloponneſians had left, with which he took Thaſus and Lampſacus. Conon was diſpatched againſt him with 180 ſhips, which being greatly ſuperior to Lyſander's fleet, that general refuſed to come to an engagement, and was blocked up in the river Ægos. While the Athenians lay there, they grew quite idle and careleſs; inſomuch that Alcibiades, who had built a caſtle for himſelf in the neighbourhood, intreated them to be more on their guard, as he well knew Lyſander's abilities. They anſwered, that they wondered at his aſſurance, who was an exile and a vagabond, to come and give laws to them; telling him, that if he gave them any farther trouble, they would ſeize and ſend him to Athens. At the ſame time they looked on victory as ſo certain, that they conſulted what they ſhould do with their priſoners; which, by the advice of Philocles their general, was, to cut off all their right hands, or according to Plutarch, their right thumbs; and Adiamantus one of their officers rendered himſelf very obnoxious by ſaying, that ſuch idle diſcourſe did not become Athenians. The conſequences of ſuch conduct may be eaſily imagined. Lyſander fell unexpectedly upon them, and gained a moſt complete victory; Conon, with eight galleys only, eſcaping to Cyprus; after which Lyſander returned to Lampſacus, where he put to death Philocles with 3000 of his ſoldiers, and all the officers except Adiamantus. This execution being over, he reduced all the cities ſubject to Athens; and with great civility ſent home their garriſons, that ſo the city might be overſtocked with inhabitants, and deſtitute of proviſions, when he came to beſiege it; which he did ſoon after by ſea, while Agis with a great army inveſted it by land.

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164 Who takes Athens.

For a long time the Athenians did not ſo much as deſire a peace; but at laſt were forced to ſend deputies to Agis, who ſent them to Sparta, where no terms could be granted except they conſented to demoliſh their walls. They next ſent to Lyſander, who after a long attendance referred them to Sparta; and thither Theramenes with ſome other deputies was immediately ſent. On their arrival, they found the council of the confederates ſitting, who all except the Spartans gave their votes that Athens ſhould be utterly deſtroyed; but they would not conſent to the ruin of that city, which had deſerved ſo well of Greece. On the return of Theramenes, peace was concluded, on condition, that the long walls and the fortifications of the port ſhould be demoliſhed; that they ſhould give up all their ſhips but 12, receive all they had baniſhed, and follow the fortune of the Lacedemonians. Theſe ſevere terms were punctually executed. Lyſander cauſed the walls to be pulled down; all the muſic in his army playing, on that very day of the year on which they had beat the Perſians at Salamine. He likewiſe eſtabliſhed an oligarchy expreſsly againſt the will of the people; and thus the ruin of Athens ended the 27th year of the Peloponneſian war, and the 404th before Chriſt.

165 Terms of peace.

166 The thirty tyrants.

As ſoon as Lyſander had demoliſhed the long walls, and the fortifications of the Piræum, he conſtituted a council of thirty, with power, as was pretended, to make laws, but in truth to ſubjugate the ſtate. Theſe are the perſons ſo famous in hiſtory, under the title of *the thirty tyrants*. They were all the creatures of Lyſander; who, as they derived their riſe from conqueſt and the law of the ſword, exerciſed their offices in a ſuitable manner; that is, with the higheſt teſtimonies of pride, inſolence, and cruelty. Inſtead of making laws, they governed without them; appointed a ſenate and magiſtrates at their will; and, that they might do all things without danger of controul, they ſent for a garriſon from Lacedemon; which was accordingly granted them, under the command of Callidius, upon their promiſe to pay the ſoldiers regularly. One of the firſt ſteps they took was to puniſh all informers; which, though ſevere, was popular: but when, through flattery and bribes, they had wholly drawn over Callidius to their party, they ſuffered bad men to live in quiet, and turned their rage againſt the good.

167 Critias and Theramenes, their oppoſite characters.

Critias and Theramenes were at the head of the thirty, men of the greateſt power and abilities in Athens. The former was ambitious and cruel without meaſure; the latter was ſomewhat more merciful: the former puſhed on all the bloody ſchemes framed by his confederates, and carried into execution many of his own; the latter always oppoſed them, at firſt with moderation, at laſt with vehemence. He ſaid, that power was given them to rule, and not to ſpoil, the

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commonwealth; that it became them to act like ſhepherds, not like wolves; and that they ought to beware of rendering themſelves at once odious and ridiculous, by attempting to domineer over all, being ſuch a handful of men as they were. The reſt, diſliking much the former part of his diſcourſe, catched hold of the latter, and immediately choſe out 3000, whom they made the repreſentatives of the people, and to whom they granted this notable privilege, that none of them ſhould be put to death but by the judgment of the ſenate, thereby openly aſſuming a power of putting any other of the Athenian citizens to death by their own authority. A glorious uſe they made of this new-aſſumed privilege; for as many as they conjectured to be no friends to the government in general, or to any of themſelves in particular, they put to death, without cauſe, and without mercy. Theramenes openly oppoſing this, and abſolutely refuſing to concur in ſuch meaſures, Critias accuſed him to the ſenate as a man of unſteady principles, ſometimes for the people, ſometimes againſt them, always for new things and ſtate-revolutions. Theramenes owned, that he had ſometimes changed his meaſures, but alledged that he had always done it to ſerve the people. He ſaid that it was ſolely with this view he made the peace with Sparta, and accepted the office of one of the thirty: that he had never oppoſed their meaſures while they cut off the wicked; but when they began to deſtroy men of fortune and family, then he owned he had differed with them, which he conceived to be no crime againſt the ſtate.

168 Theramenes put to death.

While Theramenes was ſpeaking, Critias withdrew, perceiving that the ſenate were thoroughly convinced of the truth of what Theramenes had ſaid: but he quickly returned with a guard, crying out, that he had ſtruck Theramenes's name out of the liſt of the 3000; that the ſenate had therefore no longer cognizance of the cauſe, which the thirty had already judged, and condemned him to death. Theramenes perceiving that they intended to ſeize him, fled to the altar, which was in the midſt of the ſenate-houſe, and laying his hands thereon, ſaid, "I do not ſeek refuge here becauſe I expect to eſcape death or deſire it, but that, tearing me from the altar, the impious authors of my murder may intereſt the gods in bringing them to ſpeedy judgment, and thereby reſtore freedom to my country." The guards then dragged him from the altar, and carried him to the place of execution, where he drank the poiſon with undaunted courage, putting the people in mind with his laſt breath, that as they had ſtruck his name out of the 3000, they might alſo ſtrike out any of theirs. His death was followed by a train of murders, ſo that in a ſhort time 60 of the worthieſt and moſt eminent citizens of Athens fell by the cruelty of the thirty. Amongſt theſe, the moſt pitied was Niceratus the ſon of Nicias; a man univerſally beloved for his goodneſs, and univerſally admired for his virtues. As for the Spartans, they, loſing their former generoſity, were extremely pleaſed with theſe things, and by a public decree commanded that ſuch as fled from the thirty tyrants ſhould be carried back bound to Athens: which extraordinary proceeding frightened all Greece; but the Argives and Thebans only had courage to oppoſe it: the former received the Athenian exiles with humanity and kindneſs; the latter puniſhed with a mulct ſuch of their citizens as did not riſe and reſcue the Athenian priſoners, who in purſuance of the Lacedemonian decree were carried bound through their territories.

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Thraſybulus, and ſuch as with him had taken ſhelter in the Theban territory, reſolved to hazard every thing, rather than remain perpetual exiles from their country; and though he had but 30 men, on whom he could depend, yet conſidering the victories he had heretofore obtained in the cauſe of his country he made an irruption into Attica, where he ſeized Phyla, a caſtle at a very ſmall diſtance from Athens, where in a very ſhort ſpace his forces were augmented to 700 men; and though the tyrants made uſe of the Spartan garriſon in their endeavours to reduce him and his party, yet Thraſybulus prevailed in various ſkirmiſhes, and at laſt obliged them to break up the blockade of Phyla, which they had formed. The thirty and their party conceiving it very advantageous for them to have the poſſeſſion of Eleuſina, marched thither, and having perſuaded the people to go unarmed out of their city, that they might number them, took this opportunity moſt inhumanly to murder them. The forces of Thraſybulus increaſing daily, he at length poſſeſſed himſelf of the Piræum, which he fortified in the beſt manner he could; but the tyrants being determined to drive him from thence, came down againſt him with the utmoſt force they could raiſe. Thraſybulus defended himſelf with great obſtinacy; and in the end they were forced to retreat, having loſt before the place not only a great number of their men, but Critias the preſident of the thirty, another of the ſame body, and one who had been a captain of the Piræum.

169 Thraſybulus ſeizes Phyla.

170 Critias killed.

When they came to demand the dead from Thraſybulus, in order for their interment, he cauſed a crier he had with him to make a ſhort ſpeech in a very loud voice to the people, intreating them to conſider, that as they were citizens of Athens without, ſo thoſe againſt whom they fought, and thoſe who fought to preſerve themſelves within the fort, were Athenian citizens alſo; wherefore, inſtead of thinking how to ruin and deſtroy their brethren, they ought rather to conſult how all differences ought to be compoſed, and eſpecially ought to rid themſelves of thoſe bloody tyrants, who, in the ſhort time they had had the adminiſtration in their hands, had deſtroyed more than had fallen in the Peloponneſian war. The people, though moved by theſe diſcourſes, differed among themſelves; the conſequence of which was, that they expelled the thirty, and choſe ten men out of each tribe to govern in their ſtead, whereupon the tyrants retired to Eleuſina. The citizens, however, though they changed the government, made no agreement with thoſe in the Piræum; but ſent away deputies to Sparta, as did alſo the tyrants from Eleuſina, complaining, that the Athenians had revolted, and deſiring their aſſiſtance to reduce them. The Spartans ſent thereupon a large ſum of money to encourage their confederates, and appointed Lyſander commander in chief, and his brother to be admiral; reſolving to ſend ſea and land forces to reduce Athens a ſecond time; intending, as moſt of the Greek ſtates ſuſpected, to add it now to their own dominions. It is very probable that this deſign of theirs would have taken effect, if Pauſanias king of Sparta, envying Lyſander, had not reſolved to obſtruct it. With this view, he procured another army to be raiſed againſt the Athenians,

171 The tyrants expelled.

172 Attempt of the Spartans to reduce Athens a ſecond time.

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173 How fruſtrated. The intrigues of Pauſanias had all the ſucceſs he could wiſh. The Ephori who were with him in the camp concurred in his meaſures, ſo that in a ſhort ſpace a treaty was concluded on the following terms: That all the citizens of Athens ſhould be reſtored to their houſes and privileges, excepting the thirty, the ten which had ſucceeded them and who had acted no leſs tyrannically than they, and the eleven who during the time of the oligarchy had been conſtituted governors or keepers of the Piræum; that all ſhould remain quiet for the future in the city; and that if any were afraid to truſt to this agreement, they ſhould have free leave to retire to Eleuſina. Pauſanias then marched away with the Spartan army, and Thraſybulus at the head of his forces marched into Athens, where, having laid down their arms, they ſacrificed with the reſt of the citizens in the temple of Minerva, after which the popular government was reſtored. Yet quiet was not thoroughly eſtabliſhed. The exiles at Eleuſina having endeavoured by the help of money to raiſe an army of foreigners, by whoſe aid they might recover the authority they had loſt: but firſt depending on their friends in the city, they ſent ſome of the principal perſons amongſt them as deputies, to treat with the citizens; but ſtrictly inſtructed them to ſow jealouſies and excite diſcords among them. This the latter quickly perceiving, put theſe perſons to death; and then remonſtrating to thoſe at Eleuſina, that theſe contentions would undoubtedly end either in their own or the deſtruction of their country, they offered immediately to paſs an act of oblivion, which they would confirm with an oath.

This being accepted, thoſe who had withdrawn returned to the city, where all differences were adjuſted, and both parties moſt religiouſly obſerved the agreement they had made, and thereby thoroughly reſettled the ſtate. In this whole tranſaction, the virtue of Thraſybulus deſerves chiefly to be admired. When he firſt ſeized the caſtle of Phyla, the tyrants privately offered to receive him into their number inſtead of Theramenes, and to pardon at his requeſt any 12 perſons he ſhould name: but he generouſly anſwered, That his exile was far more honourable than any authority could be, purchaſed on ſuch terms; and by perſiſting in his deſign, accompliſhed, as we have ſeen, the deliverance of his country. A glorious deliverance it was; ſince, as Iſocrates informs us, they had put 1400 citizens to death contrary to and without any form of law, and driven 5000 more into baniſhment; procuring alſo the death of Alcibiades, as many think, tho' at a great diſtance from them.

174 Virtue of Thraſybulus.

From this time to the reign of Philip of Macedon, the Athenians continued in a pretty proſperous ſituation, though they never performed any ſuch great exploits as formerly. By that monarch and his ſon Alexander all Greece was in effect ſubdued; and the hiſtory of all the Grecian ſtates from that time becomes much leſs intereſting. Of the hiſtory of Athens from that time to the preſent, the following elegant abridgment is given by Dr Chandler†. "On the death of Alexander, the Athenians revolted, but were defeated by Antipater, who gariſoned Munychia. They rebelled again, but the garriſon and oligarchy were reinſtated. Demetrius the Phalerean, who was made governor, beautified the city, and they erected to him 360 ſtatues; which on his expulſion they demoliſhed, except one in the Acropolis. Demetrius Poliorcetes withdrew the garriſon, and reſtored the democracy; when they deified him, and lodged him in the Opiſthodomos or the back part of the Parthenon, as a gueſt to be entertained by their goddeſs Minerva. Afterwards they decreed, that the Piræus, with Munychia, ſhould be at his diſpoſal; and he took the Muſeum. They expelled his garriſon, and he was perſuaded by Craterus a philoſopher to leave them free. Antigonus Gonatas, the next king, maintained a garriſon in Athens: but, on the death of his ſon Demetrius, the people, with the aſſiſtance of Aratus, regained their liberty; and the Piræus, Munychia, Salamis, and Sunium, on paying a ſum of money.

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† *Travels in Greece*, p. 28, &c.

175 Hiſtory of Athens from the time of Alexander the Great to the preſent.

"Philip, ſon of Demetrius, encamping near the city, deſtroying and burning the ſepulchres and temples in the villages, and laying their territory waſte, the Athenians were reduced to ſolicit protection from the Romans and to receive a garriſon, which remained until the war with Mithridates king of Pontus, when the tyrant Ariſtion made them revolt.

176 Athens beſieged and taken by Sylla.

"Archelaus the Athenian general, unable to withſtand the Roman fury, relinquiſhed the *long walls*, and retreated into the Piræus and Munychia. Sylla laid ſiege to the Piræus and to the city, in which Ariſtion commanded. He was informed that ſome perſons had been overheard talking in the Ceramicus, and blaming Ariſtion for his neglect of the avenues about the Heptachalcos, where the wall was acceſſible. Sylla reſolved to ſtorm there, and about midnight entered the town at the gate called *Dypylon* or *the Piræan*; having levelled all obſtacles in the way between it and the gate of the Piræus. Ariſtion fled to the Acropolis, but was compelled to ſurrender by the want of water; when he was dragged from the temple of Minerva, and put to death. Sylla burned the Piræus and Munychia, and defaced the city and ſuburbs not ſparing even the ſepulchres."

The civil war between Cæſar and Pompey ſoon followed, and their natural love of liberty made them ſide with Pompey. Here again they were unfortunate, for Cæſar conquered. But Cæſar did not treat them like Sylla, with that clemency which made ſo amiable a part of his character, he dimiſſed them by a fine alluſion to their illuſtrious anceſtors, ſaying, that he ſpared the living for the ſake of the dead.

Another ſtorm followed ſoon after this; the wars of Brutus and Caſſius with Auguſtus and Antony. Their partiality for liberty did not here forſake them: they took part in the conteſt with the two patriot Romans, and erected there ſtatues near their own ancient deliverers Harmodius and Ariſtogiton, who had ſlain Hipparchus. But they were ſtill unhappy, for their enemies triumphed.

"They next joined Antony, who gave them Ægina and Cea, with other iſlands. Auguſtus was unkind to them; and they revolted four years before he died. Under Tiberius the city was declining, but free, and regarded as an ally of the Romans. The high privi-

Attica. lege of having a lictor to precede the magiſtrates was conferred on it by Germanicus; but he was cenſured as treating with too much condeſcenſion a mixture of nations inſtead of genuine Athenians, which race was then conſidered as extinct.

"The emperor Veſpaſian reduced Achaia to a province paying tribute and governed by a proconſul. Nerva was more propitious to the Athenians; and Pliny, under Trajan his ſucceſſor, exhorts Maximus to be mindful whether he was ſent, to rule genuine Greece, a ſtate compoſed of free cities. 'You will revere the gods and heroes their founders. You will reſpect their priſtine glory, and even their age. You will honour them for the famous deeds, which are truly, nay for thoſe which are fabulouſly recorded of them. Remember, it is Athens you approach.' This city was now entirely dependent on Rome, and was reduced to ſell Delos and the iſlands in its poſſeſſion.

"Hadrian, who was at once emperor and an archon of Athens, gave the city laws, compiled from Draco, Solon, and the codes of other legiſlators; and diſplayed his affection for it by unbounded liberality. Athens reflouriſhed, and its beauty was renewed. Antoninus Pius who ſucceeded, and Antoninus the Philoſopher, were both benefactors.

The barbarians of the north, in the reign of Valerian, beſieging Theſſalonica, all Greece was terrified, and the Athenians reſtored their city-wall, which had been diſmantled by Sylla, and afterwards neglected.

"Under the next emperor, who was the archon Gallienus, Athens was beſieged, the archontic office ceaſed; and the Strategus or general, who had before acted as overſeer of the agora or market, then became the ſupreme magiſtrate. Under Claudius his ſucceſſor, the city was taken, but ſoon recovered.

"It is related, that Conſtantine, when emperor, gloried in the title of *general of Athens*; and rejoiced exceedingly on obtaining from the people the honour of a ſtatue with an inſcription, which he acknowledged by a yearly gratuity of many buſhels of grain. He conferred on the governor of Attica and Athens the title of *grand duke* μεγας δουξ. That office was at firſt annual, but afterwards hereditary. His ſon Conſtans beſtowed ſeveral iſlands on the city, to ſupply it with corn.

"In the time of Theodoſius the Firſt, 380 years after Chriſt, the Goths laid waſte Theſſaly and Epirus; but Theodore, general of the Achæans, by his prudent conduct preſerved the cities of Greece from pillage, and the inhabitants from being led into captivity. A ſtatue of marble was erected to him at Athens by order of the city; and afterwards one of braſs, by command of the emperor, as appears from an inſcription in a church dedicated to a ſaint of the ſame name, not far from the French convent. It is on a round pedeſtal, which ſupports a flat ſtone ſerving for the holy table. Eudocia the wife of Theodoſius the ſecond was an Athenian.

177 By Alaric the Goth. "The fatal period now approached, and Athens was about to experience a conqueror more ſavage even than Sylla. This was Alaric king of the Goths; who under the emperors Arcadius and Honorius, over-ran Greece and Italy, ſacking, pillaging, and deſtroying. Then the Peloponneſian towns were overturned, Arcadia and Lacedemon were laid waſte, the two ſeas by the Iſthmus were burniſhed with the flames of Corinth, and the Athenian matrons were dragged in chains by barbarians. The invaluable treaſures of antiquity, it is related, were removed; the ſtately and magnificent ſtructures converted into piles of ruin; and Athens was ſtripped of every thing ſplendid or remarkable. Syneſius a writer of that age, compares the city to a victim, of which the body had been conſumed, and the hide only remained. Attica.

"After this event, Athens became an unimportant place, and as obſcure as it once had been famous. We read that the cities of Hellas were put into a ſtate of defence by Juſtinian, who repaired the walls, which at Corinth had been ſubverted by an earthquake, and at Athens and in Bœotia were impaired by age: and here we take a long farewel of this city. A chaſm of near 700 years enſues in its hiſtory, except that, about the year 1130, it furniſhed Roger the firſt king of Sicily with a number of artificers, whom he ſettled at Palermo, where they introduced the culture of ſilk, which then paſſed into Italy. The worms had been brought from India into Conſtantinople in the reign of Juſtinian.

"Athens as it were, re-emerges from oblivion in the 13th century, under Baldwin, but beſieged by a general of Theodorus Laſcaris, the Greek emperor. It was taken in 1427 by Sultan Morat. Boniface, marquis of Montſerrat, poſſeſſed it with a garriſon; after whom it was governed by Delves, of the houſe of Arragon. On his death, it was ſeized, with Macedonia, Theſſaly, Bœotia, Phocis, and the Peloponneſus, by Bajazet; and then, with the iſland Zante, by the Spaniards of Catalonia in the reign of the Greek emperor Andronicus Palæologus the elder. Theſe were diſpoſſeſſed by Reinerius Acciaioli, a Florentine; who, leaving no legitimate male iſſue, bequeathed it to the ſtate of Venice. His natural ſon, Antony, to whom he had given Thebes with Bœotia, expelled the Venetians. He was ſucceeded in the dukedom by his kinſman Nerius, who was diſplaced by his own brother named *Antony*, but recovered the government when he died. Nerius leaving only an infant ſon, was ſucceeded by his wife. She 178 was ejected by Mahomet on a complaint from Francus By the ſon of the ſecond Antony, who confined her at Me- Turks. gara and made away with her; but her ſon accuſing him to Mahomet the Second, the Turkiſh army under Omar advanced, and he ſurrendered the citadel in 1455; the Latins refuſing to ſuccour him unleſs the Athenians would embrace their religious tenets. Mahomet, it is related, when he had finiſhed the war with the deſpot of the Morea, four years after, ſurveyed the city and Acropolis with admiration. The janizaries informed him of a conſpiracy; and Francus Acciaioli, who remained lord of Bœotia, was put to death. In 1464 the Venetians landed at the Piræus, ſurpriſed the city, and carried off their plunder and captives to Eubœa.

"It is remarkable, that after theſe events Athens was again in a manner forgotten. So lately as about the middle of the 16th century, the city was commonly believed to have been utterly deſtroyed, and not to exiſt, except a few huts of poor fiſhermen. Cræſius, a learned and inquiſitive German, procured more authentic information from his Greek correſpondents reſiding in Turky, which he publiſhed in 1584, to awaken curioſity and to promote farther diſcoveries. One of theſe letters is from a native of Nauplia, a town near Argos

in

Attica. in the Morea. This writer ſays, that he had been often at Athens, and that it ſtill contained many things worthy to be ſeen, ſome of which he enumerates, and then ſubjoins: "But why do I dwell on this place? It is as the ſkin of an animal that has been long dead."

It now remains to give ſome idea of the character, government, and religion of this once ſo famous people.

179 Character of the ancient Athenians.

The Athenians, ſays Plutarch, are very ſubject to violent anger; but they are ſoon pacified. They are likewiſe eaſily impreſſed with humanity and compaſſion. That this was their temper, is proved by many hiſtorical examples. We ſhall produce a few. The ſentence of death pronounced againſt the inhabitants of Mitylene, and revoked the next day: The condemnation of Socrates, and that of the ten chiefs, each followed by quick repentance and moſt pungent grief.

The minds of the ſame people adds Plutarch, are not formed for laborious reſearches. They ſeize a ſubject, as it were by intuition; they have not patience and phlegm enough to examine it gradually and minutely. This part of their character may ſeem ſurpriſing and incredible. Artiſans, and and other people of their rank, are in general ſlow of comprehenſion. But the Athenians of every degree were endowed with an inconceivable vivacity, penetration, and delicacy of taſte. Even the Athenian ſoldiers could repeat the fine paſſages of the tragedies of Euripides. Thoſe artiſans and thoſe ſoldiers aſſiſted at public debates, were bred to political affairs, and were equally acute in apprehenſion and in judgment. We may infer the underſtanding of the hearers of Demoſthenes from the genius of his orations, which were laconic and poignant.

As their inclination, continues Plutarch, leads them to aſſiſt and ſupport people of low condition, they like diſcourſe ſeaſoned with pleaſantry, and productive of mirth. The Athenians patronize people of low degree; becauſe from them their liberty is in no danger, and becauſe ſuch patronage tends to ſupport a democratical conſtitution. They love pleaſantry; which turn of mind proves that they are a humane ſocial people, who have a taſte for raillery and wit, and are not ſoured with that reſerve which marks the deſpot or the ſlave.

They take pleaſure in hearing themſelves praiſed; but they can likewiſe patiently bear raillery and cenſure. We know with what art and ſucceſs Ariſtophanes and Demoſthenes applied their praiſe and their irony to the Athenian people. When the republic enjoyed peace, ſays the ſame Plutarch in another place, it encouraged the adulation of its orators: but when it had important affairs to diſcuſs, when the ſtate was in danger, it became ſerious; and preferred, to its eloquent ſycophants, the honeſt orators who oppoſed its follies and its vices: ſuch ingenious and bold patriots as a Pericles, a Phocion, and a Demoſthenes.

The Athenians, continues Plutarch, often make their governors tremble, and ſhow great humanity to their enemies. They were very attentive to the information and inſtruction of thoſe citizens who were moſt eminent for their policy and eloquence; but they were on their guard againſt the ſuperiority of their talents; they often checked their boldneſs, and repreſſed their exuberant reputation and glory. That this was their temper, we are convinced by the oſtraciſm; which was eſtabliſhed to reſtrain the ambition of thoſe who had great talents and influence, and which ſpared neither the greateſt nor the beſt men. The deteſtation of tyranny and tyrants, which was inherent in the Athenians, rendered them extremely jealous of their privileges, made them zealous and active in defence of their liberty, whenever they thought it was violated by men in power. Attica.

As to their enemies, they did not treat them with rigour. They did not abuſe victory by a brutal inhumanity to the vanquiſhed. The act of amneſty, which they paſſed after the uſurpation of the 30 tyrants, proves that they could eaſily forgive injuries. It was this mildneſs, this humanity of diſpoſition, which made the Athenians ſo attentive to the rules of politeneſs and decorum. In their war with Philip, having ſeized one of his couriers, they read all the letters he bore, except one from Olympias to her huſband, which they ſent back unopened. Such was their veneration of love and conjugal ſecrecy; thoſe ſacred rights, which no enmity, no hoſtility, warrants us to violate!

The views of conqueſt cheriſhed by a ſmall republic, were extenſive and aſtoniſhing; but this people, ſo great ſo ambitious in their projects, were, in other reſpects, of a different character. In the expences of the table, in dreſs, in furniture, in houſes, in ſhort, in private life, they were frugal, ſimple, modeſt, poor; but ſumptuous and magnificent whenever the honour of the ſtate was concerned. Their conqueſts, their victories, their riches, their connections with the inhabitants of Aſia Minor, never reduced them to luxury, to riot, to pomp, to profuſion. Xenophon remarks, that a citizen was not diſtinguiſhed from a ſlave by his dreſs. The wealthieſt citizen, the moſt renowned general, was not aſhamed to go himſelf to market.

The taſte of the Athenians, for all the arts and ſciences, is well known. When they had delivered themſelves from the tyranny of Piſiſtratus, and after this had defeated the vaſt efforts of the Perſians, they may be conſidered as at the ſummit of their national glory. For more than half a century afterwards they maintained, without controul, the ſovereignty of Greece; and that aſcendant produced a ſecurity, which left their minds at eaſe, and gave them leiſure to cultivate every thing liberal or elegant. It was then that Pericles adorned the city with temples, theatres, and other beautiful public buildings. Phidias, the great ſculptor, was employed as his architect, who, when he had erected edifices, adorned them himſelf; and added ſtatues and baſſo-relievo's, the admiration of every beholder. It was then that Polignotus and Myro painted; that Sophocles and Euripides wrote; and not long after, that they ſaw the divine Socrates.

Human affairs are, by nature, prone to change; and ſtates, as well as individuals, are born to decay. Jealouſy and ambition inſenſibly fomented wars, and ſucceſs in theſe wars, as in others, was often various. The military ſtrength of the Athenians was firſt impaired by the Lacedemonians; after that, it was again hu-

Attica. humiliated, under Epaminondas, by the Thebans: and laſt of all it was wholly cruſhed by the Macedonian, Philip.

Nor, when their political ſovereignty was loſt, did their love of literature and arts ſink along with it. Juſt at the cloſe of their golden days of empire flouriſhed Xenophon and Plato, the diſciples of Socrates, and from Plato deſcended that race of philoſophers called the *Old Academy*. Ariſtotle, who was Plato's diſciple, may be ſaid, not to have invented a new philoſophy, but rather to have tempered the ſublime and rapturous myſteries of his maſter with method, order, and a ſtricter mode of reaſoning. Zeno, who was himſelf alſo educated in the principles of Platoniſm, only differed from Plato in the comparative eſtimate of things, allowing nothing to be intrinſically good but virtue, nothing intrinſically bad but vice, and conſidering all other things to be in themſelves indifferent. He too and Ariſtotle accurately cultivated logic, but in different ways; for Ariſtotle chiefly dwelt upon the ſimple ſyllogiſm; Zeno upon that which is derived out of it, the compound or hypothetic. Both too, as well as other philoſophers, cultivated rhetoric along with logic; holding a knowledge in both to be requiſite for thoſe who think of addreſſing mankind with all the efficacy of perſuaſion. Zeno elegantly illuſtrated the force of theſe two powers by a ſimile, taken from the hand: the cloſe power of logic he compared to the fiſt, or hand compreſt: the diffuſe power of logic, to the palm, or hand open.

The new academy was founded by Arceſilas, and ably maintained by Carneades. From a miſtaken imitation of the great parent of philoſophy Socrates (particularly as he appears in the dialogues of Plato), becauſe Socrates doubted ſome things, therefore Arceſilas and Carneades doubted all.—Epicurus drew from another ſource; Democritus had taught him atoms and a void: by the fortuitous concourſe of atoms he fancied he could form a world; while by a feigned veneration he complimented away his gods, and totally denied their providential care, leſt the trouble of it ſhould impair their uninterrupted ſtate of bliſs. Virtue he recommended, though not for the ſake of virtue, but pleaſure: pleaſure, according to him, being our chief and ſovereign good. See ARISTOTLE, EPICURUS, PLATO, SOCRATES, &c.

We have already mentioned the alliance between philoſophy and rhetoric. This cannot be thought wonderful, if rhetoric be the art by which men are perſuaded, and if men cannot be perſuaded without a knowledge of human nature: for what but philoſophy can procure us this knowledge? It was for this reaſon the ableſt Greek philoſophers not only taught, but wrote alſo treatiſes upon rhetoric. They had a farther inducement, and that was the intrinſic beauty of their language as it was then ſpoken among the learned and polite. They would have been aſhamed to have delivered philoſophy, as it has been too often delivered ſince, in compoſitions as clumſy as the common dialect of the mere vulgar.

The ſame love of elegance, which made them attend to their ſtyle, made them attend even to the places where their philoſophy was taught. Plato delivered his lectures in a place ſhaded with groves, on the banks of the river Iliſſus; and which, as it once belonged to a perſon called *Academus*, was called after his name, the ACADEMY. Ariſtotle choſe another ſpot of a ſimilar character, where there were trees and ſhade; a ſpot called the LYCÆUM. Zeno tanght in a portico or colonnade, diſtinguiſhed from other buildings of that ſort (of which the Athenians had many) by the name, the *Variegated Portico*, the walls being decorated with various paintings of Polygnotus and Myro, two capital maſters of that tranſcendent period. Epicurus addreſſed his hearers in thoſe well known gardens, called, after his own name, *The gardens of Epicurus*. Attica.

Theſe places of public inſtitution were called among the Greeks by the name of *Gymnaſia*; in which, whatever that word might have originally meant, were taught all thoſe exerciſes, and all thoſe arts, which tended to cultivate not only the body but the mind. As man was a being conſiſting of both, the Greeks could not conſider that education as complete, in which both were not regarded, and both properly formed. Hence their Gymnaſia, with reference to this double end, were adorned with two ſtatues, thoſe of Mercury and of Hercules, the corporeal accompliſhments being patroniſed (as they ſuppoſed) by the god of ſtrength, the mental accompliſhments by the god of ingenuity.

It was for the cultivation of every liberal accompliſhment that Athens was celebrated (as we have ſaid) during many centuries, long after her political influence was loſt and at an end.

She was the place of education, not only for Greeks but for Romans. It was hither that Horace was ſent by his father; it was here that Cicero put his ſon Marcus under Cratippus, one of the ableſt philoſophers then belonging to that city.—The ſects of philoſophers, which we have already deſcribed, were ſtill exiſting when St Paul came thither. We cannot enough admire the ſuperior eloquence of that apoſtle, in his manner of addreſſing ſo intelligent an audience. We cannot enough admire the ſublimity of his exordium; the propriety of his mentioning an altar which he had found there; and his quotation from Aratus, one of their well-known poets. Nor was Athens only celebrated for the reſidence of philoſophers, and the inſtitution of youth: men of rank and fortune found pleaſure in a retreat, which contributed ſo much to their liberal enjoyment.

We ſhall finiſh this picture of the Athenians by the addition of one object more, to which every one will admit they have a right; an object which was prominent and ſtriking, in all their actions and in all their enterprizes: we mean their ardent love of liberty. This was their predominant quality; the main ſpring of their government. From the beginning of the Perſian war they ſacrificed every thing to the liberty of Greece. They left, without heſitation, their cities, their houſes, to fight at ſea the common enemy, from whom they were in danger of ſervitude. What a glorious day was it for Athens, when all her allies, growing flexible to the advantageous offers which were made to them by the king of Perſia, ſhe replied by Ariſtides, to the ambaſſadors of that monarch,—"That it was impoſſible for all the gold in the world to tempt the republic of Athens: to prevail with her to ſell her liberty, and that of Greece." It was by theſe generous ſenti-

Attica. sentiments that the Athenians not only became the bulwark of Greece, but likewiſe guarded the reſt of Europe from a Perſian invaſion.

Theſe great qualities were blended with great failings, ſeemingly incompatible with Patriotiſm. For the Athenians, notwithſtanding their tenacious jealouſy of the rights of their country, were a volatile, inconſtant capricious people.

180 Religion. There never was a people more attentive to the worſhip of the gods than the Athenians. The worſhip of their principal deities was diffuſed over all Greece, and even beyond its limits.

Each temple had its particular religious rites: the pomp, the ceremonies, the duration, and the ſucceſſion of the ſolemn feaſts, were all appointed by fixed rules. The worſhip paid to each divinity, whether public or private, was founded on traditions, or on laws conſtantly obeyed. The feaſt of Bacchus, the Panathenæa, the feaſt of the myſteries of Eleuſis, were celebrated according to eſtabliſhed rules, moſt of which were as ancient as the feaſts themſelves. The old cuſtoms, of which the prieſts were the guardians, were obſerved in the temples. It is probable that the prieſts were conſulted on affairs in which the worſhip of a deity was intereſted, and that their anſwer was deciſive. We are certain that the Eumolpidæ had this authority. They were the interpreters of the ancient laws on which the worſhip of Ceres was founded, its magnificence, and its mode—laws which were not written, as Lyſias informs us, but were perpetuated by a conſtant obſervation. The abuſes which had gradually crept into the celebration of thoſe feaſts, had given riſe to ſeveral new regulations; to that of the orator Lycurgus, for example, and to the law of Solon, which enjoined the ſenate to repair to Eleuſis on the ſecond day of the feaſt; but neither theſe nor the other particular regulations which we find in Samuel Petit's collection of Attic laws, could make a religious code. There was no general ſyſtem which comprehended all the branches of their religion, which, by combining all its articles, might regulate their belief and conduct, and direct the judges in their deciſions.

181 Crimes againſt religion why ſometimes puniſhed with ſeverity. Crimes againſt religion were only puniſhed as they affected the ſtate; and conſequently they were tried by the magiſtrate. Mere raillery, though ſomewhat profane, was thought productive of no worſe conſequence than offending the miniſters of the gods. The Athenians acknowledged no other religion than the hereditary public worſhip; no other gods than thoſe they had received from their anceſtors; no other ceremonies than thoſe which had been eſtabliſhed by the laws of the ſtate, and practiſed by their country from time immemorial. They were only ſolicitous to preſerve this worſhip, which was cloſely interwoven with their government, and made a part of its policy. They were likewiſe attentive to the ceremonial pomp; becauſe order, the regular vigour of legiſlation, depends greatly on the awe impreſſed by externals. But as to the inconſiſtent and monſtrous romance of fables, foreign opinions, popular traditions, and poetical fictions, which formed a religion quite different from that of the ſtate—in it they were very little intereſted, and allowed every one to think of it as he pleaſed.

This explanation will reconcile a ſeeming contradiction in the conduct of the Athenians, who gave great licence to their poets, and ſeverely puniſhed the citizens who were guilty of impiety. Ariſtophanes, who made as free with the gods as with the great, was applauded by the Athenians. They condemned Socrates to death, who revered the deity, but diſapproved the public manner of worſhipping him. The life of Æſchylus was in danger from a ſuſpicion that he had revealed ſome of the ſecrets of Eleuſis in one of his pieces. The wit of Ariſtophanes's drama was unpuniſhed. Attica.

182 Prieſts their duty. The prieſts were not confined to the care of the altars; they who were veſted with the ſacerdotal dignity, which was only incompatible with profeſſions merely uſeful and lucrative, might likewiſe hold the moſt important offices of the commonwealth. This we could prove by a great number of examples; we ſhall cite that of Xenophon the illuſtrious hiſtorian and philoſopher: he was likewiſe a famous general, and he was a prieſt. He was performing the ſacerdotal function when he received the news of his ſon's death, who was killed at the battle of Mantinèa.

The ſacred miniſtry was not only compatible with civil offices, but likewiſe with the profeſſion of arms. The prieſt and the ſoldier were often blended. Callias, the prieſt of Ceres, fought at Platæa. This cuſtom was not peculiar to the Athenians. The Lacedemonians, after the battle which we have juſt mentioned, made three graves for their ſlain; one for the prieſts, one for the other Spartans, and one for the Helots.

183 Sacred revenues, &c. As every mean employment was incompatible with the ſacerdotal dignity, the prieſts had a revenue fixed to their office. We know that a part of the victims was their right, and that apartments were aſſigned them near the temples. But, beſide theſe advantages, they had a ſalary proportioned to the dignity of their functions and to the rank of the deities whom they ſerved. Their ſalary was probably paid from the revenue of the temples. Thoſe revenues, which kept the temples in repair, and defrayed the ſacrificial expences, were very conſiderable. They were of many different kinds.

A great part of the ſacred revenues aroſe from fines, which individuals were condemned to pay for various offences; fines, of which the tenth part was appropriated to Minerva Polias, and the fiftieth to the other gods and to the heroes whoſe names their tribes bore. Beſides, if the Prytanes did not hold the aſſemblies conformably with the laws, they were obliged to pay a fine of 1000 drachms to the goddeſs. If the Proedri, *i. e.* the ſenators whoſe office it was to lay before the aſſembly the matters on which they were to deliberate, did not diſcharge that duty according to the rules preſcribed to them, they were likewiſe condemned to pay a fine, which, as the former, was applied to the uſe of Minerva. By theſe fines her temple muſt have been greatly enriched.

Beſides this revenue, which was the common property of the gods, and which varied according to the number and degrees of the miſdemeanors, the temples had their permanent revenues: We mean the produce of the lands which were conſecrated to the deities. We do not here allude to the lands conſecrated to the gods, which were never to be cultivated; ſuch as the territory of Cirrha, proſcribed by a ſolemn decree of

Attica. the Amphictyons; the land betwixt Megara and Attica, which was conſecrated to the goddeſſes of Eleuſis, and many others. We would ſpeak only of thoſe which were cultivated, the fruits of which enriched the temples.

There were likewiſe lands belonging to the ſtate, the produce of which was deſtined to defray the expence of the ſacrifices which were offered in the name of the republic. There were likewiſe firſt-fruits which the public officers levied on all lands, for the uſe of the gods. All theſe emoluments made a part of the revenue of the temples.

The gods, beſides the revenues immediately appertaining to their temples, had certain rights which were granted them by particular compact. The Lepreatæ, for inſtance, were obliged to pay every year a talent to Olympian Jupiter, on account of a treaty of alliance which they made with the Eleans in one of their wars. The inhabitants of Epidaurus, to obtain leave from the Athenians to cut down olive-trees for ſtatues, which the Pythian prieſteſs had commanded them to make, engaged to ſend deputies every year to Athens, to offer ſacrifices in their name to Minerva and to Neptune. But this prerogative was rather honorary than lucrative.

The tenth part of the ſpoils taken in war was likewiſe the property of Minerva. Sacred veſſels were bought with the effects of the 30 tyrants. In ſhort, the gods were profited by almoſt every public accident. But what contributed moſt to enrich the famous temples of Greece, was the money which was conſtantly brought to them by individuals, in conſequence of vows they had made, or to pay for ſacrifices which were offered in their names. The credulity of the people was an inexhauſtible fund. That credulity enriched the temples of Deli and Eleuſis, and ſupported the magnificence of Delphi. And thoſe immenſe treaſures which were the fruit of ſuperſtition, were often a prey to avarice.

Theſe revenues were not depoſited with the prieſts; nor did they expend them. A moderate ſalary was all their gain; and to offer ſacrifices to the deities whoſe miniſters they were, was all their employment.

It is very probable that all the ſacred revenues were paid into the hands of officers who were appointed to receive them, and who were to give an account of the diſcharge of their truſt. Nay, we cannot doubt of this, after reading a paſſage in Ariſtotle, who, ſpeaking of the officers of the temples, expreſsly mentions thoſe who were entruſted with the money appertaining to the gods. Citizens, without doubt, of approved integrity, were choſen to this office; and their duty muſt have been, to keep the temples in repair and order, and to diſburſe and keep an account of the ordinary ſacred expences.

As to the ſolemn feaſts, which were incredibly magnificent, ſuch as the feaſt of Bacchus, and the Panathenæa, they were celebrated at the expence of the Chorègus; *i. e.* of the chief of the choir of each tribe: for each tribe had its poet and its muſicians, who ſung, emulating each other, hymns in honour of the deity. The richeſt citizens were appointed chiefs of the different choirs; and as their office was very expenſive, to indemnify them in ſome degree, the Chorègus of the victorious tribe had the privilege of engraving his name on the tripod which that tribe ſuſpended to the roof of the temple. This office, though ruinous, was eagerly ſolicited; and naturally, in a republican ſtate. It led to honours, like the Curule dignity at Rome; and it greatly tended to ingratiate its poſſeſſor with a people, who were more affected with pleaſures than with eſſential ſervices, and who, conſequently, would more highly eſteem a profuſe Chorègus than a victorious general. Attica.

With regard to the fines, which were in the whole, or in part, the property of Minerva and of the other deities, there were at Athens public treaſurers appointed to receive them. They were ten in number, and they were nominated by lot. They were called *Treaſurers of the Goddeſs*, or *Receivers of the ſacred money*. That money they received in the preſence of the ſenate; and they were empowered to diminiſh or to annihilate the fine, if they thought it unjuſt. The ſtatue of Minerva, that of the victories, and the other invaluable pledges of the duration of the ſtate, were depoſited with them.

The treaſury in which the money conſecrated to the gods was kept, was in the citadel, behind the temple of Minerva Polias; and from its ſituation it was termed *Opiſtodomus*. It was ſurrounded with a double wall. It had but one door, the key of which was kept by the Epiſtates, or chief of the Prytanes: his dignity was very conſiderable; but it laſted only one day. In this treaſury a regiſter was kept, in which were written the names of all thoſe who were indebted to the ſtate: he who owed the ſmalleſt fine was not omitted. If the debtors proved inſolvent, they were proſecuted with extreme rigour, and often puniſhed with a cruelty which religion could not excuſe; though the intereſt of the gods was the motive, or rather the pretext. The ſacred treaſurers held a conſiderable rank among the magiſtrates, who received the public finances. Of theſe magiſtrates there were many kinds, as there were many ſorts of revenues.

The Athenian prieſts did not compoſe an order diſtinct and ſeparate from the other orders of the ſtate. They did not form a body united by particular laws, under a chief whoſe authority extended to all his inferiors. The dignity of ſovereign pontiff was unknown at Athens; and each of the prieſts ſerved his particular temple, connected with his brethren. The temples, indeed, of the principal deities; thoſe of Minerva, for inſtance, of Neptune, of Ceres, and of Proſerpine, had many miniſters; and in each of them a chief preſided, who had the title of *High-Prieſt*. The number of ſubaltern miniſters was in proportion to the rank of the deity; but the prieſts of one temple were altogether a ſeparate ſociety from thoſe of another. Thus at Athens there was a great number of high prieſts, becauſe many deities were worſhipped there, whoſe ſervice required many miniſters. The power of each prieſt was confined to his temple; and there was no ſovereign pontiff, the miniſter general of the gods, and the preſident at all the feaſts.

It naturally follows from this account, that the miniſters of the gods at Athens were not judges in matters of religion. They were neither authoriſed to take cogniſance of crimes committed againſt the deity, nor to puniſh them. Their function was to offer ſacrifices to the gods, and to intreat their acceptance of the ado-

Attica. adorations of the people. But the puniſhment of impiety, of ſacrilege, of the profanation of myſteries, and of other irreligious crimes, was not entruſted to their zeal.

The prieſts were not only incapable of avenging crimes againſt religion by a temporal proceſs; they even could not, without an expreſs order either from the ſenate or the people, exerciſe their right of devoting criminals to the infernal gods. It was in conſequence of a civil ſentence pronounced againſt Alcibiades, that the Eumolpidæ launched their anathema againſt him. It was in virtue of another decree that they revoked their imprecations, when his countrymen wanted his ſervice, and therefore reſtored him to their favour.

Religious cauſes, according to M. de Bougainville, fell under the juriſdiction of the Heliaſtæ.

The government, though often altered, continued pretty much on the plan eſtabliſhed by Solon.

184 People divided into different tribes, &c.

The people of Athens were freemen, ſojourners, or ſlaves. The citizens, called in Greek *Politai*, were very numerous; but what may ſeem ſtrange, were as many in the time of Cecrops as in the moſt flouriſhing ſtate of the commonwealth, hardly ever exceeding 20,000. It was Solon who decreed that none ſhould be accounted free but ſuch as were Athenians both by father and mother. After his time it fell into deſuetude, till revived by Pericles, and again at his inſtance repealed. After the expulſion of the 30 tyrants, Solon's law was reſtored. A perſon born of a ſtranger was ſtyled *Nothos*, a baſtard; whereas the ſon of a free woman was called *Cneſios*, i. e. *legitimate*. There was in Cynoſarges a court of judicature, to which cauſes of illegitimacy properly belonged; and the utmoſt care was taken to prevent any from being inrolled Athenian citizens, who had not a clear title thereto. The citizens were divided by Cecrops into four tribes: the firſt called *Cecropes*, from Cecrops; the ſecond, *Autochthon*, from a king of that name; the third, *Actai*, from Acteus another king of Athens, or rather from *Acte*, which ſignifies a *ſhore*: the fourth, *Pluralia*: theſe names were altered by Cranaus, and again by Erichthonius. In the reign of Erictheus, they were again changed: the ſoldiers were called *Oplitai*, the craftſmen *Ergatai*, the farmers *Georgoi*, the graziers and ſhepherds *Aigicorai*: in this ſtate they were when Solon ſettled the commonwealth, and appointed the ſenate to be compoſed of 400, 100 out of each tribe. Clyſthenes increaſed the number of the tribes to 10; and made the ſenate conſiſt of 500, taking 50 out of each tribe. In ſucceeding times, two other tribes were added. Each tribe was ſubdivided into its *Demoi* or wards; and with reſpect to theſe it was that Solon inſtituted the public feaſts beforementioned, at which ſometimes the whole tribe aſſembled, ſometimes ſeveral wards, and ſometimes only the inhabitants of one ward.

The ſecond ſort of inhabitants we mentioned were called *Metoicoi*, i. e. *ſojourners*; theſe were perſons who lived always at Athens, yet were not admitted free denizens; as for ſuch as did not conſtantly reſide in Athens, they were ſtyled *Xenoi*; i. e. *ſtrangers*. The ſojourners were obliged to chooſe out of the citizens protectors, who were ſtyled *Patrons*: they paid ſervices to the ſtate, and beſides theſe an annual tribute of 12 drachms for every man, and ſix for every woman; but ſuch as had ſons, and paid for them, were exempted. If people fell to poverty, and were not able to pay the tribute, they were ſeized by the taxmaſters, and actually ſold for ſlaves: which, as Diogenes Laertius tells us, was the fate of Xenocrates the philoſopher. The ſojourners in Attica were under the ſame law as thoſe in Athens. As to ſervants, they were freemen, who through indigency were driven to receive wages, and while they were in this ſtate had no vote in the aſſembly. As to ſlaves, they were abſolutely the property of their maſters, and as ſuch were uſed as they thought fit: They were forbidden to wear clothes, or to cut their hair like their maſters; and which is indeed amazing, Solon prohibited them to love boys, as if that had been honourable: They were likewiſe debarred from anointing or perfuming themſelves, and from worſhipping certain deities: They were not allowed to be called by honourable names; and in moſt other reſpects were uſed like dogs. They ſtigmatized them at their pleaſure, that is, branded them with letters in the forehead and elſewhere. However, Theſeus's temple was allowed them as a ſanctuary, whither, if they were exceedingly ill uſed, they might fly, and thereby oblige their owners to let them be transferred to another maſter. In this and many other reſpects the Athenian ſlaves were in a much better condition than thoſe throughout the reſt of Greece: they were permitted to get eſtates for themſelves, giving a ſmall premium to their maſters, who were obliged to make them free if they could pay their ranſom; they likewiſe obtained the ſame favour from the kindneſs of their maſters, or for having rendered military ſervices to the ſtate. When they were made free, they were obliged to chooſe patrons; and had likewiſe the privilege of chooſing a curator, who, in caſe their patrons injured them, was bound to defend them. Attica.

185 General aſſembly of the people.

The general aſſembly of the people, which Solon made the dernier reſort, was called the *Eccleſia*; and conſiſted of all the freemen of Athens, excepting ſuch as were *atimoi* or infamous. The meetings of theſe aſſemblies were either ordinary or extraordinary. The ordinary were ſuch as were appointed by law, the extraordinary ſuch as neceſſity required. Of the firſt there were four in 35 days. In the firſt aſſembly they approved or rejected magiſtrates, heard propoſals for the public good, and certain cauſes. In the ſecond they received petitions, and heard every man's judgement on the matters that were before them. In the third they gave audience to foreign ambaſſadors. The fourth was employed altogethen in affairs relating to the gods and their worſhip. The extraordinary meetings were appointed by the magiſtrates when occaſion required, whereas to the ordinary aſſemblies the people came of their own accord. The firſt were held either in the market-place, in the Pnyx, a place near the citadel, or in the theatre of Bacchus; as to the latter, the magiſtrates who appointed the extraordinary meeting appointed alſo the place where they ſhould be held. If any ſudden tempeſt aroſe, or any earthquake happened, or any ſign notoriouſly inauſpicious appeared, the aſſembly was immediately adjourned, to prevent the people from apprehending unhappy conſequences from their deliberations. But if the weather was fair and ſerene, and nothing happened out of the ordinary courſe of things, they proceeded to purify the place where

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the aſſembly was held, which was done by ſprinkling it round with the blood of young pigs: then the crier made a ſolemn prayer for the proſperity of the republic, and that heaven would beſtow a happy iſſue on their counſels and undertakings; he then pronounced a bitter execration againſt any who ſhould in that aſſembly propound what might be diſadvantageous to the ſtate. Theſe ceremonies being over, they proceeded to buſineſs.

186 Method of giving their opinions.

There were ſeveral magiſtrates who had the overſeeing and regulating theſe aſſemblies. Theſe were, firſt, the Epiſtate, or preſident of the aſſembly, who was choſen by lot out of the Proedri: his office was to give the ſignal for the people's voting. Next to him were the Prytanes, *i. e.* a committee of the ſenate, who of courſe were preſent on this occaſion: by their order a programma, or ſcheme of the buſineſs to be propoſed at the aſſembly, was previouſly ſet up in ſome public place, that every man might know what buſineſs to apply his thoughts to. The Proedri were nine in number, appointed by lots out of all the tribes to which the Prytanes did not belong: they had the right of propoſing to the people what they were to deliberate upon, and their office ended with the aſſembly; there ſat with them aſſeſſors, who were to take care that nothing they propoſed was detrimental to the commonwealth. The firſt ſtep to buſineſs was the crier's reading the decree of the ſenate whereon the aſſembly was to deliberate; when he had finiſhed this, he made proclamation in theſe words: *Who of the men above* 50 *will make an oration?* When the old men had done ſpeaking, the crier made proclamation again that any Athenian might then offer his ſentiments, whom the law allowed ſo to do; that is, all ſuch as were above 30 years old, and were not infamous. If ſuch a one roſe up to ſpeak, the Prytanes interpoſed, and bid him be ſilent; and if he did not obey them, the lictors pulled him down by force. When the debates were over, the preſident permitted the people to vote; which they did by caſting firſt beans, but in after-times pebbles, into certain veſſels: theſe were counted, and then it was declared that the decree of the ſenate was either rejected or approved:

187 The ſenate.

after which, the Prytanes diſmiſſed the aſſembly.

The ſenate was inſtituted by Solon to prevent the dangerous conſequences of leaving the ſupreme power in the people. At the time of his inſtitution, it was to conſiſt of 400, 100 out of each tribe; it was increaſed to 500, when the tribes were augmented to 10; and when they came to 12, it was alſo ſwelled to 600. They were elected by lots after this manner: At a day appointed, towards the cloſe of the year, the preſident of each tribe gave in a liſt of ſuch perſons belonging thereto, as were fit for and deſired to appear for this dignity: theſe names were engraven on tablets of braſs, and a number of beans equal to the number of the amount of them, among which were 100 white ones, put into a veſſel; and then the names of the candidates and the beans were drawn one by one, and ſuch as were drawn by the white beans were received into the ſenate. After the ſenate was elected, they proceeded to appoint the officers who were to preſide in the ſenate: theſe were the Prytanes beforementioned, and they were elected thus: The names of the ten tribes were thrown into one veſſel, and nine black beans and a white one into another veſſel. Then the names of the tribes were drawn with the beans. The tribe to which the white bean anſwered, preſided firſt; and the reſt according to the order in which they were drawn.

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188 Prytanes.

The Prytanes, while the ſenate conſiſted of 500, were 50 in number. For the farther avoiding of confuſion therefore, 10 of theſe preſided a week, during which ſpace they were called *Proedri*; and out of theſe an Epiſtate or preſident was choſen, whoſe office laſted but one day, and by law no man could hold it more than once: the reaſon of this was, that he had in his cuſtody the public ſeal, the keys of the citadel, and the charge of the exchequer. The reader muſt diſtinguiſh between the Epiſtates and Proedri laſt-mentioned, and thoſe ſpoken of in the former paragraph, becauſe, though their titles were the ſame, their office were perfectly diſtinct. The ſenate aſſembled by direction of the Prytanes once every day, excepting feſtivals, and ſometimes oftner in the ſenate-houſe, which was thence called *Prytaneum*.

189 Laws how eſtabliſhed, &c.

When a member of the ſenate made a motion for a new law, it was immediately engraven on tablets, that the members when they came next might be prepared to ſpeak to it. At the ſubſequent aſſembly the Epiſtates opened the matter, after which every ſenator that pleaſed delivered his ſentiments; then any of the Prytanes drew up the decree, and repeated it aloud: after which they proceeded to vote, and if there was a majority of white beans, then it became *pſephiſma*, and was afterwards propounded to the people: if they approved it, it became a law; otherwiſe it was of no force longer than the ſenate who decreed it ſubſiſted. The power of the ſenate was very great: for they took the account of magiſtrates at the expiration of their offices; they directed the proviſions made for poor citizens out of the public treaſure; they had the ſuperintendancy of public priſons, and a power of puniſhing ſuch as committed acts morally evil, though not prohibited by any law; they had the care likewiſe of the fleet; and beſides all theſe they had many other branches of authority, which it is not neceſſary for us to mention. Before they took their ſeats, they were conſtrained to undergo a very ſtrict examination, wherein the whole courſe of their lives was inquired into; and if the leaſt ſlur on their reputation appeared, they were ſet aſide. When this examination was over, they took an oath, whereby they bound themſelves to promote in all their councils the public good, to adviſe nothing contrary to the laws, and to execute their functions exactly. The higheſt fine the ſenate could impoſe was 500 drachms: if they thought the offender deſerved a heavier mulct, they then tranſmitted the cauſe to the Theſmothetæ, who puniſhed them as they thought fit. The ſenators, when their year was out, gave an account of their management to the people: but that they might have the leſs to do, they always puniſhed ſuch of their number as they found had offended, by expulſion; and in this they were mighty exact. Yet an expelled ſenator was notwithſtanding eligible to any other office, the moſt trivial omiſſion being ſufficient to occaſion a diſmiſſion from the ſenatorial dignity; and therefore, when the tribes choſe their ſenators, they alſo choſe a certain number of ſubſidiaries, out of which, when a ſenator was expelled, another was ſubſtituted in his place. Each ſenator was allowed a drachm every day: for it was a conſtant rule with the Athenians, that the public

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ought to pay for every man's time; and therefore such of the poor Athenians as thought fit to demand it, had three oboli for going to the assembly. If during their administration any ships of war were built, the senators had crowns decreed them; but if not, they were forbid to sue for them.

Next to the senate was the court of AREOPAGUS, for a description of which see that article.

200 Archons, Nomophylaces, &c.

The chief magistrates of Athens were Archons, and inferior to them there were many others; of whom it will be necessary to mention some. In the first place they had Nomophylaces, who were also styled *the eleven*, because they were so many in number, one chosen out of each tribe, and a clerk or secretary who made up the eleventh. Their duty it was to look to the execution of the laws: they had authority to seize robbers and other capital offenders; and if they confessed, to put them to death. Dr Potter thinks they resembled our sheriffs. The Phylarchi were the presidents of the Athenian tribes; but in time this became a military title. The Philobasileus was an officer in each tribe, who did the same things within his jurisdiction as the Basileus did with respect to the state. The Demarchi were the principal magistrates in wards. The Lexarchi were six in number, and were bound to take care that the people came duly to the assemblies; in their custody was the public register of the citizens names. They had under them Toxotæ, who were lictors or bailiffs; they were sometimes 1000 in number: these men were necessary: but, like most of their sort, were in a manner infamous, as may be gathered from the comedies of Aristophanes; they were generally Scythians, raw-boned, brawny fellows, ready to execute any thing they were commanded. The Nomothetæ were 1000 in number; their business was to watch over and inspect into the laws. There were two sorts of orators in the service of the state, some were appointed to defend an old law, when a motion was made to repeal it; these had their fee from the state, but the same man was incapable of being elected twice. Besides these, there were 10 settled orators called *Rhetores*, elected by lot; their business was to plead public causes in the senate-house.

201 Laws regarding orators.

For this they had their stated fees; and with respect to their qualifications, the law run thus: "Let no one be a public orator who hath struck his parents, denied them maintenance, or shut them out of his doors; who hath refused to serve in the army; who hath thrown away his shield; who hath been addicted to lewd women, notoriously effeminate, or who has run out his patrimony. If any man who has been guilty of these crimes dare to deliver an oration, let him be brought to trial upon the spot. Let an orator have children lawfully begotten, and an estate within Attica; if in his oration he talks impertinently, makes idle repetitions, affects an unbecoming raillery, digresses from the point in question, or after the assembly is over, abuses the president, let the Proedri fine him 50 drachms; and if that is not thought enough, let him be brought before the next assembly and fined again."

202 Courts of justice.

We shall conclude this draught of the Athenian government with an account of their courts of justice, which, exclusive of the Areopagus, were 10 in number; four had cognisance of criminal, and six of civil causes. These 10 courts were numbered with the 10 first letters of the alphabet, and were thence styled, *Alpha*, *Beta*, *Gamma*, &c. When an Athenian was at leisure to hear causes, he wrote his own name, that of his father, and the ward to which he belonged, upon a tablet; this he presented to the Thesmothetæ, who returned it again to him with another tablet, with the letter which fell to his lot; then he went to the crier of the court, who presented him a sceptre, and gave him admission. When the causes were over, every judge went and delivered his sceptre to the Prytanes, and received a stated fee for every cause that was tried. But as this was intended only to compensate their loss of time, so that there might be no appearance of covetousness, a man was forbid to sit in two courts on the same day. The first criminal court after the Areopagus, was that of the *Ephetæ*. It consisted of 51 members, all upwards of 51 years old. Draco gave it a very extensive jurisdiction; but Solon took away from them the power of judging in any other causes than those of manslaughter, accidental killing, and lying in wait to destroy: the Basileus entered all causes in this court. The second criminal court was called *Delphinium*, because it was held in the temple of Apollo Delphinius; it had cognisance of such murders as were confessed by the criminal, but at the same time justified under some pretence or other. The *Prytaneum* was the third criminal court. It held plea of such cases where death ensued from inanimate things: causes were heard here with the same solemnity as in other courts; and on judgment given, the thing, or whatever it was, that had occasioned the death of a man, was thrown out of the territory of Athens. The last criminal court was styled *Phreatum*. It sat in a place not far from the sea-shore; and such persons were brought before this court as had committed murders in their own country and fled to Attica: the proceedings of this court were so severe that they did not permit the criminal to come on shore, but obliged him to plead his cause in his vessel; and if he was found guilty, he was committed to the mercy of the wind and seas.

Of the judicatures for hearing civil causes, the first was the *Parabaston*, so called, as some think, because in it no matter could be heard if the cause of action was above one drachm. The *Cainon*, or new court, was the second tribunal. The third was styled the *court of Lycus*, because it assembled in a temple dedicated to that hero, whose statue, represented with the face of a wolf, was set up in all courts of justice. The *Trigonon* was so called, because it was triangular in its form. The court of *Metidius* derived its appellation from the architect who built it. The sixth and last court was called *Heliæa*; it was by far the greatest, and is generally conceived to have derived its name from the judges sitting in the open air exposed to the sun. All the Athenians who were free citizens were allowed by law to sit in these courts as judges; but before they took their seats were sworn by Apollo Patrius, Ceres, and Jupiter the king, that they would decide all things righteously and according to law, where there was any law to guide them; and by the rules of natural equity, where there was none. The Helæastic court consisted at least of 50, but its usual number was 500, judges: when causes of very great consequence were to be tried, 1000 sat therein, and now and then the judges were increased to 1500, and even to 2000. There were many inferior courts in Athens for the decision of tri-

Atticus, Attila.

vial cauſes; but of theſe there is no neceſſity of ſpeaking, ſince we deſign no more than a ſuccinct view of the Athenian republic, as it was ſettled by and in conſequence of Solon's laws.

ATTICUS (Titus Pomponius), one of the moſt honourable men of ancient Rome. He underſtood the art of managing himſelf with ſuch addreſs, that, without leaving his ſtate of neutrality, he preſerved the eſteem and affection of all parties. His ſtrict friendſhip with Cicero did not hinder him from having great intimacy with Hortenſius. The conteſts at Rome between Cinna's party and that of Marius induced him to go to Athens, where he continued for a long time. He was very fond of polite learning, and kept at his houſe ſeveral librarians and readers. He might have obtained the moſt conſiderable poſts in the government; but choſe rather not to meddle, becauſe in the corruption and faction which then prevailed he could not diſcharge them according to the laws. He wrote Annals. He married his daughter to Agrippa; and attained to the age of 77.

ATTILA, king of the Huns, ſurnamed *the ſcourge of God*, lived in the 5th century. He may be ranked among the greateſt conquerors, ſince there was ſcarcely any province in Europe which did not feel the weight of his victorious arms.

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Attila deduced his noble, perhaps his regal, deſcent from the ancient Huns, who had formerly contended with the monarchs of China. His features, according to the obſervation of a Gothic hiſtorian, bore the ſtamp of his national origin; and the portrait of Attila exhibits the genuine deformity of a modern Caulmuck; a large head, a ſwarthy complexion, ſmall deep-ſeated eyes, a flat noſe, a few hairs in the place of a beard, broad ſhoulders, and a ſhort ſquare body, of nervous ſtrength, though of a diſproportioned form. The haughty ſtep and demeanour of the king of the Huns expreſſed the conſciouſneſs of his ſuperiority above the reſt of mankind; and he had a cuſtom of fiercely rolling his eyes, as if he wiſhed to enjoy the terror which he inſpired. Yet this ſavage hero was not inacceſſible to pity; his ſuppliant enemies might confide in the aſſurance of peace or pardon; and Attila was conſidered by his ſubjects as a juſt and indulgent maſter. He delighted in war: but, after he had aſcended the throne in a mature age, his head, rather than his hand atchieved the conqueſt of the north; and the fame of an adventurous ſoldier was uſefully exchanged for that of a prudent and ſucceſsful general. The effects of perſonal valour are ſo inconſiderable, except in poetry or romance, that victory, even among barbarians, muſt depend on the degree of ſkill, with which the paſſions of the multitude are combined and guided for the ſervice of a ſingle man. The Arts of Attila were ſkilfully adapted to the character of his age and country. It was natural enough, that the Scythians ſhould adore, with peculiar devotion, the god of war; but as they were incapable of forming either an abſtract idea, or a corporeal repreſentation, they worſhipped their tutelar deity under the ſymbol of an iron ſcimitar. One of the ſhepherds of the Huns perceived, that a heifer, who was grazing, had wounded herſelf in the foot; and curiouſly followed the track of the blood, till he diſcovered, among the long graſs the point of an ancient ſword; which he dug out of the ground, and preſented to Attila. That magnanimous, or rather that artful prince, accepted with pious gratitude this celeſtial favour; and, as the rightful poſſeſſor of the *ſword of Mars*, aſſerted his divine and indefeaſible claim to the dominion of the earth. If the rites of Scythia were practiſed on this ſolemn occaſion, a lofty altar, or rather pile of faggots, 300 yards in length and in breadth, was raiſed in a ſpacious plain; and the ſword of Mars was placed erect on the ſummit of this ruſtic altar, which was annually conſecrated by the blood of ſheep, horſes, and of the hundredth captive. Whether human ſacrifices formed any part of the worſhip of Attila, or whether he propitiated the god of war with the victims which he continually offered in the field of battle, the favourite of Mars ſoon acquired a ſacred character, which rendered his conqueſts more eaſy and more permanent; and the barbarian princes confeſſed, in the language of devotion or flattery, that they could not preſume to gaze with a ſteady eye on the divine majeſty of the king of the Huns. His brother Bleda, who reigned over a conſiderable part of the nation, was compelled to reſign his ſceptre and his life. Yet even this cruel act was attributed to a ſupernatural impulſe; and the vigour with which Attila wielded the ſword of Mars, convinced the world that it had been reſerved alone for his invincible arm. But the extent of his empire affords the only remaining evidence of the number and importance of his victories; and the Scythian monarch, however ignorant of the value of ſcience and philoſophy, might perhaps lament that his illiterate ſubjects were deſtitute of the art which could perpetuate the memory of his exploits.

Attila.

If a line of ſeparation were drawn between the civilized and the ſavage climates of the globe; between the inhabitants of cities who cultivated the earth, and the hunters and ſhepherds who dwelt in tents; Attila might aſpire to the title of ſupreme and ſole monarch of the Barbarians. He alone, among the conquerors of ancient and modern times, united the two mighty kingdoms of Germany and Scythia; and thoſe vague appellations, when they are applied to his reign, may be underſtood with an extenſive latitude. Thuringia, which ſtretched beyond its actual limits as far as the Danube, was in the number of his provinces: he interpoſed, with the weight of a powerful neighbour, in the domeſtic affairs of the Franks; and one of his lieutenants chaſtiſed, and almoſt exterminated, the Burgundians of the Rhine. He ſubdued the iſlands of the ocean, the kingdoms of Scandinavia, encompaſſed and divided by the waters of the Baltic; and the Huns might derive a tribute of furs from that northern region, which has been protected from all other conquerors by the ſeverity of the climate, and the courage of the natives. Towards the eaſt, it is difficult to circumſcribe the dominion of Attila over the Scythian deſerts: yet we may be aſſured, that he reigned on the banks of the Volga, that the king of the Huns was dreaded, not only as a warrior, but as a magician; that he inſulted and vanquiſhed the Khan of the formidable Geougen: and that he ſent ambaſſadors to negociate an equal alliance with the empire of China. In the proud review of the nations who acknowledged the ſovereignty of Attila, and who never entertained during his lifetime the thought of a revolt, the Gepidæ and the Oſtrogoths were

Attila | Attorney.

were diſtinguiſhed by their numbers, their bravery, and the perſonal merit of their chiefs. The renowned Ardaric king of the Gepidæ, was the faithful and ſagacious councellor of the monarch; who eſteemed his intrepid genius, whilſt he loved the mild and diſcreet virtues of the noble Walamir king of the Oſtrogoths. The crowd of vulgar kings, the leaders of ſo many martial tribes, who ſerved under the ſtandard of Attila, were ranged in the ſubmiſſive order of guards and domeſtics round the perſon of their maſter. They watched his nod; they trembled at his frown; and at the firſt ſignal of his will, they executed without murmur or heſitation his ſtern and abſolute commands. In time of peace, the dependent princes, with their national troops, attended the royal camp in regular ſucceſſion; but when Attila collected his military force, he was able to bring into the field an army of five, or, according to another account, of ſeven hundred thouſand Barbarians.

For an account of his exploits and death, ſee the article HUNS.

ATTIRE, in hunting, ſignifies the head or horns of a deer. The attire of a ſtag, if perfect, conſiſts of bur, pearls, beams, gutters, antler, ſur-antler, royal, ſur-royal, and crotches; of a buck, of the bur, beam, brow-antler, advancer, palm, and ſpellers.

ATTITUDE, in painting and ſculpture, the geſture of a figure or ſtatue; or it is ſuch a diſpoſition of their parts as ſerves to expreſs the action and ſentiments of the perſon repreſented.

ATTIUM, (anc. geog.) a promontory on the north-weſt of Corſica, (Ptolemy). It ſtill retains ſome traces of its ancient name, being now called *Punta di Acciuolo* (Cluverius).

ATTLEBURY, a town in the county of Norfolk in England. E. Long. 0. 40. N. Lat. 52. 23.

ATTOLLENS, in anatomy, an appellation given to ſeveral muſcles otherwiſe called *levatores* and *elevatores*. See ANATOMY, *Table of the Muſcles*.

ATTORNEY AT LAW, anſwers to the Procurator, or Proctor of the civilians and canoniſts: And he is one who is put in the place, ſtead, or turn of another, to manage his matters of law. Formerly every ſuitor was obliged to appear in perſon, to proſecute or defend his ſuit (according to the old Gothic conſtitution), unleſs by ſpecial licence under the king's letters patent. This is ſtill the law in criminal caſes. And an idiot cannot to this day appear by attorney, but in perſon; for he hath not diſcretion to enable him to appoint a proper ſubſtitute; and upon his being brought before the court in ſo defenceleſs a condition, the judges are bound to take care of his intereſts, and they ſhall admit the beſt plea in his behalf that any one preſent can ſuggeſt. But, as in the Roman law, *cum olim in uſu fuiſſet, alterius nomine agi non poſſe, ſed, quia hoc non minimam incommoditatem habebat, cœperunt homines per procuratores litigare*; ſo, in England, on the ſame principle of convenience, it is now permitted in general, by divers ancient ſtatutes, whereof the firſt is ſtatute Weſt. 2. c. 10. that attorneys may be made to proſecute or defend any action in the abſence of the parties to the ſuit. Theſe attorneys are now formed into a regular corps; they are admitted to the execution of their office by the ſuperior courts of Weſtminſter-hall; and are in all points officers of the reſpective courts in which they are admitted; and as they have many privileges on account of their attendance there, ſo they are peculiarly ſubject to the cenſure and animadverſion of the judges. No man can practiſe as an attorney in any of thoſe courts, but ſuch as is admitted and ſworn an attorney of that particular court; an attorney of the court of king's bench cannot practiſe in the court of common pleas; nor *vice verſa*. To practiſe in the court of chancery, it is alſo neceſſary to be admitted a ſolicitor therein; and by the ſtatute 22 Geo. II. c. 46. no perſon ſhall act as an attorney at the court of quarter-ſeſſions, but ſuch as has been regularly admitted in ſome ſuperior court of record. So early as the ſtatute 4 Henry IV. c. 18. it was enacted, that attorneys ſhould be examined by the judges, and none admitted but ſuch as were virtuous, learned, and ſworn to do their duty. And many ſubſequent ſtatutes have laid them under farther regulations. Attorney, Attraction.

Letter of attorney pays by different acts, 6s. By 25 Geo. III. c. 80. the following duties are to be paid by every ſolicitor, attorney, notary, proctor, agent or procurator, viz. for every warrant to proſecute for a debt of 40s. or to defend, a ſtamp duty of 2s. 6d. And they are to take out certificates annually; and if reſident in London, Weſtminſter, the bills of mortality, or Edinburgh, they are now obliged to pay L. 5 for the ſame; and in every other part of Great Britain, L. 3. The duties are under the management of the commiſſioners of ſtamps: and every acting ſolicitor, and other perſon as above, ſhall annually deliver in a note of his name and reſidence, to the proper officer of the court in which he practiſes; the entering officers are to certify notes delivered, and iſſue annual certificates, ſtamped as above, which muſt be renewed ten days before the expiration. Refuſing to iſſue, or improperly iſſuing certificates, is a penalty of L. 50, and damages to the party aggrieved. Acting without a certificate, or giving in a falſe place of reſidence, is a penalty of L. 50, and incapacity to ſue for fees due. A ſtamped memorandum ſhall be given to the proper officer, of the names of the parties in every action; and in ſuch caſes as uſed to require precipes. Officers who receive ſtamped memorandums, are to file the ſame, on penalty of L. 50; and perſons not acting conformable to this act forfeit L. 5.

ATTORNEY General, is a great officer under the king, made by letters patent. It is his place to exhibit informations, and proſecute for the crown, in matters criminal; and to file bills in the exchequer, for any thing concerning the king in inheritance or profits; and others may bring bills againſt the king's attorney. His proper place in court, upon any ſpecial matters of a criminal nature, wherein his attendance is required, is under the judges on the left hand of the clerk of the crown; but this is only upon ſolemn and extraordinary occaſions; for uſually he does not ſit there, but within the bar in the face of the court.

ATTOURNMENT, or ATTORNMENT, in law, a transfer from one lord to another of the homage and ſervice a tenant makes; or that acknowledgment of duty to a new lord.

ATTRACTION, in natural philoſophy, a general term uſed to denote the cauſe by which bodies tend towards

Attraction. towards each other, and cohere till ſeparated by ſome other power.

The principle of attraction, in the Newtonian ſenſe of it, ſeems to have been firſt ſurmiſed by Copernicus. "As for gravity," ſays Copernicus, "I conſider it as nothing more than a certain natural appetence (*appetentia*) that the Creator has impreſſed upon all the parts of matter, in order to their uniting or coaleſcing into a globular form, for their better preſervation; and it is credible that the ſame power is alſo inherent in the ſun and moon, and planets, that thoſe bodies may conſtantly retain that round figure in which we behold them." *De Rev. Orb. Cæleſt.* lib. i. cap. 9. And Kepler calls gravity a corporeal and mutual affection between ſimilar bodies, in order to their union. *Aſt. Nov. in Introd.* And he pronounces more poſitively, that no bodies whatſoever were abſolutely light, but only relatively ſo; and conſequently, that all matter was ſubjected to the law of gravitation. *Ibid.*

The firſt in Britain who adopted the notion of attraction, was Dr Gilbert, in his book *De Magnete*; and the next was the celebrated Lord Bacon, *Nov. Org.* lib. ii. aphor. 36. 45. 48. *Sylv.* cent. i. exp. 33. In France it was received by Fermat and Roberval; and in Italy by Galileo and Borelli. But till Sir Iſaac Newton appeared, this principle was very imperfectly defined and applied.

It muſt be obſerved, that though this great author makes uſe of the word attraction, in common with the ſchool philoſophers; yet he very ſtudiouſly diſtinguiſhes between the ideas. The ancient attraction was ſuppoſed a kind of quality, inherent in certain bodies themſelves, and ariſing from their particular or ſpecific forms. The Newtonian attraction is a more indefinite principle; denoting not any particular kind or manner of action, nor the phyſical cauſe of ſuch action; but only a tendency in the general, a *conatus accedendi*, to whatever cauſe, phyſical or metaphyſical, ſuch effect be owing; whether to a power inherent in the bodies themſelves, or to the impulſe of an external agent. Accordingly, that author, in his *Philoſoph. Nat. Prin. Math.* notes, "that he uſes the words *attraction*, *impulſe*, and *propenſion* to the center, indifferently; and cautions the reader not to imagine that by attraction he expreſſes the modus of the action, or the efficient cauſe thereof, as if there were any proper powers in the centres, which in reality are only mathematical points; or, as if centres could attract." Lib. i. p. 5. So he "conſiders centripetal powers as attractions, though, phyſically ſpeaking, it were perhaps more juſt to call them impulſes. Ib. p. 147. He adds, "that what he calls attraction may poſſibly be effected by impulſe, though not a common or corporeal impulſe, or after ſome other manner unknown to us." *Optic.* p. 322.

Attraction, if conſidered as a quality ariſing from the ſpecific form of bodies, ought, together with ſympathy, antipathy, and the whole tribe of occult qualities, to be exploded. But when we have ſet theſe aſide, there will remain innumerable phenomena of nature, and particularly the gravity or weight of bodies, or their tendency to a centre, which argue a principle of action ſeemingly diſtinct from impulſe, where at leaſt their is no ſenſible impulſion concerned. Nay, what is more, this action in ſome reſpects differs from all impulſion we know of; impulſe being always found to act in proportion to the ſurfaces of bodies, whereas gravity acts according to their ſolid content, and conſequently muſt ariſe from ſome cauſe that penetrates or pervades the whole ſubſtance thereof. This unknown principle, unknown we mean in reſpect of its cauſe, for its phenomena and effects are moſt obvious, with all the ſpecies and modifications thereof, we call *attraction*; which is a general name, under which all mutual tendencies, where no phyſical impulſe appears, and which cannot therefore be accounted for from any known laws of nature, may be ranged. Attraction.

And hence ariſe divers particular kinds of attraction; as, *Gravity*, *Magnetiſm*, *Electricity*, &c. which are ſo many different principles acting by different laws, and only agreeing in this, that we do not ſee any phyſical cauſes thereof; but that, as to our ſenſes, they may really ariſe from ſome power or efficacy in ſuch bodies, whereby they are enabled to act even upon diſtant bodies, though our reaſon abſolutely diſallows of any ſuch action.

Attraction may be divided, with reſpect to the law it obſerves, into two kinds.

1. That which extends to a ſenſible diſtance. Such are the attraction of gravity, found in all bodies; and the attraction of magnetiſm and electricity, found in particular bodies. The ſeveral laws and phenomena of each, ſee under their reſpective articles.

The attraction of gravity, called alſo among mathematicians the *centripetal force*, is one of the greateſt and moſt univerſal principles in all nature. We ſee and feel it operate on bodies near the earth, and find by obſervation that the ſame power (*i. e.* a power which acts in the ſame manner, and by the ſame rules, *viz.* always proportionably to the quantities of matter, and as the ſquares of the diſtances reciprocally) does alſo obtain in the moon, and the other planets, primary and ſecondary, as well as in the comets; and even that this is the very power whereby they are all retained in their orbits, &c. And hence, as gravity is found in all the bodies which come under our obſervation, it is eaſily inferred, by one of the ſettled rules of philoſophizing, that it obtains in all others: and as it is found to be as the quantity of matter in each body, it muſt be in every particle thereof; and hence every particle in nature is proved to attract every other particle, &c. See the demonſtration hereof laid down at large, with the application of the principle to the celeſtial motions, under the article ASTRONOMY, Sect. IV.

From this attraction ariſes all the motion, and conſequently all the mutation, in the great world. By this heavy bodies deſcend, and light ones aſcend; by this projectiles are directed, vapours and exhalations riſe, and rains, &c. fall. By this rivers glide, the air preſſes, the ocean ſwells, &c. In effect, the motions ariſing from this principle make the ſubject of that extenſive branch of mathematics, called *mechanics* or *ſtatics*, with the parts or appendages thereof, hydroſtatics, pneumatics, &c.

2. That which does not extend to ſenſible diſtances. Such is found to obtain in the minute particles whereof bodies are compoſed, which attract each other at or extremely near the point of contact, with a force much ſuperior to that of gravity, but which at any diſtance from it decreaſes much faſter than the power

of

Attraction. of gravity. This power a late ingenious author chooſes to call the *attraction of coheſion*, as being that whereby the atoms or inſenſible particles of bodies are united into ſenſible maſſes. Attraction.

This latter kind of attraction owns Sir Iſaac Newton for its diſcoverer; as the former does for its improver. The laws of motion, percuſſion, &c. in ſenſible bodies under various circumſtances, as falling, projected, &c. aſcertained by the later philoſophers, do not reach to thoſe more remote, inteſtine motions of the component particles of the ſame bodies, whereon the changes of the texture, colour, properties, &c. of bodies depend: ſo that our philoſophy, if it were only founded on the principle of gravitation, and carried ſo far as that would lead us, would neceſſarily be very deficient.

But beſide the common laws of ſenſible maſſes, the minute parts they are compoſed of are found ſubject to ſome others, which have been but lately taken notice of, and are even yet imperfectly known. Sir Iſaac Newton, to whoſe happy penetration we owe the hint, contents himſelf to eſtabliſh that there are ſuch motions in the *minima naturæ*, and that they flow from certain powers or forces, not reducible to any of thoſe in the great world. In virtue of theſe powers, he ſhows, "That the ſmall particles act on one another even at a diſtance; and that many of the phenomena of nature are the reſult thereof. Senſible bodies, we have already obſerved, act on one another divers ways; and as we thus perceive the tenor and courſe of nature, it appears highly probable that there may be other powers of the like kind: nature being very uniform and conſiſtent with herſelf. Thoſe juſt mentioned reach to ſenſible diſtances, and ſo have been obſerved by vulgar eyes; but there may be others which reach to ſuch ſmall diſtances as have hitherto eſcaped obſervation; and it is probable electricity may reach to ſuch diſtances, even without being excited by friction."

The great author juſt mentioned proceeds to confirm the reality of theſe ſuſpicions from a great number of phenomena and experiments, which plainly argue ſuch powers and actions between the particles, *e. g.* of ſalts and water, oil of vitriol and water, aquafortis and iron, ſpirit of vitriol and ſaltpetre. He alſo ſhows, that theſe powers, &c. are unequally ſtrong between different bodies; ſtronger, *e. g.* between the particles of ſalt of tartar and thoſe of aquafortis than thoſe of ſilver, between aquafortis and lapis calaminaris than iron, between iron than copper, copper than ſilver or mercury. So ſpirit of vitriol acts on water, but more on iron or copper, &c.

The other experiments which countenance the exiſtence of ſuch principle of attraction in the particles of matter are innumerable.

Theſe actions, in virtue whereof the particles of the bodies abovementioned tend towards each other, the author calls by a general indefinite name, *attraction*; which is equally applicable to all actions whereby diſtant bodies tend towards one another, whether by impulſe or by any other more latent power: and from hence he accounts for an infinity of phenomena, otherwiſe inexplicable, to which the principle of gravity is inadequate.

"Thus (adds our author) will nature be found very conformable to herſelf, and very ſimple; performing all the great motions of the heavenly bodies by the attraction of gravity, which intercedes thoſe bodies, and almoſt all the ſmall ones of their parts, by ſome other attractive power diffuſed through the particles thereof. Without ſuch principles, there never would have been any motion in the world; and without the continuance thereof, motion would ſoon periſh, there being otherwiſe a great decreaſe or diminution thereof, which is only ſupplied by theſe active principles."

We need not ſay how unjuſt it is in the generality of foreign philoſophers to declare againſt a principle which furniſhes ſo beautiful a view, for no other reaſon but becauſe they cannot conceive how one body ſhould act on another at a diſtance. It is certain, philoſophy allows of no action but what is by immediate contact and impulſion (for how can a body exert any active power there where it does not exiſt? to ſupppoſe this of any thing, even the Supreme Being himſelf, would perhaps imply a contradiction): yet we ſee effects without ſeeing any ſuch impulſe; and where there are effects, we can eaſily infer there are cauſes whether we ſee them or no. But a man may conſider ſuch effects without entering into the conſideration of the cauſes, as indeed it ſeems the buſineſs of a philoſopher to do: for to exclude a number of phenomena which we do ſee, will be to leave a great chaſm in the hiſtory of nature; and to argue about actions which we do not ſee, will be to build caſtles in the air.—It follows, therefore, that the phenomena of attraction are matters of phyſical conſideration, and as ſuch intitled to a ſhare in the ſyſtem of phyſics; but that the cauſes thereof will only become ſo when they become ſenſible, *i. e.* when they appear to be the effect of ſome other higher cauſes (for a cauſe is no otherwiſe ſeen than as itſelf is an effect, ſo that the firſt cauſe muſt from the nature of things be inviſible): we are therefore at liberty to ſuppoſe the cauſes of attractions what we pleaſe, without any injury to the effects.—The illuſtrious author himſelf ſeems a little irreſolute as to the cauſes; inclining ſometimes to attribute gravity to the action of an immaterial cauſe (*Optics*, p. 343, &c.) and ſometimes to that of a material one (Ib. p. 325.)

In his philoſophy, the reſearch into cauſes is the laſt thing, and never comes under conſideration till the laws and phenomena of the effect be ſettled; it being to theſe phenomena that the cauſe is to be accommodated. The cauſe even of any, the groſſeſt and moſt ſenſible action, is not adequately known. How impulſe or percuſſion itſelf produces its effects, *i. e.* how motion is communicated by body to body, confounds the deepeſt philoſophers; yet is impulſe received not only into philoſophy, but into mathematics: and accordingly the laws and phenomena of its effects make the greateſt part of common mechanics.

The other ſpecies of attraction, therefore, in which no impulſe is remarkable, when their phenomena are ſufficiently aſcertained, have the ſame title to be promoted from phyſical to mathematical conſideration; and this without any previous inquiry into their cauſes, which our conceptions may not be proportionate to: let their cauſes be occult, as all cauſes ſtrictly ſpeaking are, ſo that their effects, which alone immediately concern us, be but apparent.

Attraction | Attributives.

Our great philoſopher, then, far from adulterating ſcience with any thing foreign or metaphyſical, as many have reproached him with doing, has the glory of having thrown every thing of this kind out of his ſyſtem, and of having opened a new ſource of ſublimer mechanics, which duly cultivated might be of infinitely greater extent than all the mechanics yet known. It is hence alone we muſt expect to learn the manner of the changes, productions, generations, corruptions, &c. of natural things; with all that ſcene of wonders opened to us by the operations of chemiſtry.

Some ſucceeding philoſophers have proſecuted the diſcovery with laudable zeal: Dr Keil particularly has endeavoured to deduce ſome of the laws of this new action, and applied them to ſolve divers of the more general phenomena of bodies, as coheſion, fluidity, elaſticity, ſoftneſs, fermentation, coagulation, &c.; and Dr Friend, ſeconding him, has made a further application of the ſame principles, to account at once for almoſt all the phenomena that chemiſtry preſents: ſo that ſome philoſophers are inclined to think that the new mechanics ſhould ſeem already raiſed to a complete ſcience, and that nothing now can occur but what we have an immediate ſolution of from the attractive force.

But this ſeems a little too precipitate: A principle ſo fertile ſhould have been further explored; its particular laws, limits, &c. more induſtriouſly detected and laid down, before we had proceeded to the application. Attraction in the groſs is ſo complex a thing, that it may ſolve a thouſand different phenomena alike. The notion is but one degree more ſimple and preciſe than action itſelf; and, till more of its properties are aſcertained, it were better to apply it leſs and ſtudy it more. It may be added, that ſome of Sir Iſaac Newton's followers have been charged with falling into that error which he induſtriouſly avoided, viz. of conſidering attraction as a cauſe or active property in bodies, not merely as a phenomenon or effect.

Attraction of Mountains. See Mountains.

Elective Attraction. See Chemistry-*Index*.

ATTREBATII. See Atrebatii.

ATTRIBUTE, in a general ſenſe, that which agrees with ſome perſon or thing; or a quality determining ſomething to be after a certain manner. Thus underſtanding is an attribute of mind, and extenſion an attribute of body. That attribute which the mind conceives as the foundation of all the reſt, is called its *eſſential attribute*: thus extenſion is by ſome, and ſolidity by others, eſteemed the eſſential attributes of body or matter.

ATTRIBUTES, in theology, the ſeveral qualities or perfections of the Divine nature.

Attributes, in logic, are the predicates of any ſubject, or what may be affirmed or denied of any thing.

Attributes, in painting and ſculpture, are ſymbols added to ſeveral figures, to intimate their particular office and character. Thus the eagle is an attribute of Jupiter; a peacock, of Juno; a caduce, of Mercury; a club, of Hercules; and a palm, of Victory.

ATTRIBUTIVES, in grammar, are words which are ſignificant of attributes; and thus include adjectives, verbs, and particles, which are attributes of ſubſtances; and adverbs, which denote the attributes only of attributes. But Harris, who has introduced this diſtribution of words, denominates the former *attributives of the firſt order*, and the latter *attributives of the ſecond order*.

Attrition | Avalanches.

ATTRITION, the rubbing or ſtriking of bodies one againſt another, ſo as to throw off ſome of their ſuperficial particles.

ATURÆ, an ancient town in the diſtrict of Novempopulana in Aquitania, on the river Aturus; now Aire in Gaſcony, on the Adour. E. Long. 0. 3. N. Lat. 43. 40.

AVA, a kingdom of Aſia, in the peninſula beyond the Ganges. The king is very powerful, his dominions being bounded by Mogulſtan on the weſt, Siam on the ſouth, Tonquin and Cochin-China on the eaſt, and by Tibet and China on the north. Several large rivers run through this country, which annually overflow their banks like the Nile, and thus render it extremely fertile. Here are mines of lead and copper, together with ſome of gold and ſilver, beſides large quantities of the fineſt oriental rubies, ſapphires, emeralds, &c.

Ava, the metropolis of the kingdom of the ſame name, is ſituated in E. Long. 96. 30. N. Lat. 21. 0. It is pretty large; the houſes built with timber or bamboo canes, with thatched roofs, and floors made of teak plank or ſplit bamboo. The ſtreets are very ſtraight, with rows of trees planted on each ſide. The king's palace is an exact quadrangle, each ſide of which is 800 paces, and is ſurrounded with a brick wall; but the palace itſelf is of ſtone. It has four gates: the golden gate, through which all ambaſſadors enter; the gate of juſtice, through which the people bring petitions, accuſations, or complaints; the gate of grace, through which thoſe paſs who have received any favours, or have been acquitted of crimes laid to their charge; and the gate of ſtate, through which his majeſty himſelf paſſes when he ſhows himſelf to the people.

AVA ava, a plant ſo called by the inhabitants of Otaheite, in the South Sea, from the leaves of which they expreſs an intoxicating juice. It is drank very freely by the chiefs and other conſiderable perſons, who vie with each other in drinking the greateſt number of draughts, each draught being about a pint: but it is carefully kept from their women.

AVADOUTAS, a ſect of Indian Bramins, who in auſterity ſurpaſs all the reſt. The other ſects retain earthen veſſels for holding their proviſions, and a ſtick to lean on: but none of theſe are uſed by the Avadoutas; they only cover their nakedneſs with a piece of cloth; and ſome of them lay even that aſide, and go ſtark naked, beſmearing their bodies with cow-dung. When hungry, ſome go into houſes, and, without ſpeaking, hold out their hand; eating on the ſpot whatever is given them. Others retire to the ſides of holy rivers, and there expect the peaſants to bring them proviſions, which they generally do very liberally.

AVAIL of Marriage, in Scots law, that caſualty in ward-holding, by which the ſuperior was intitled to a certain ſum from his vaſſal, upon his attaining the age of puberty, as the value or avail of his tocher.

AVALANCHES, a name given to prodigious ſnow-balls that frequently roll down the mountains in Savoy

Avalon | Aubonne

Savoy, particularly Mount Blanc, to the extreme danger of ſuch adventurous travellers as attempt to aſcend thoſe ſtupendous heights. Some of the avalanches are about 200 feet diameter; being fragments of the ice-rocks which break by their own weight from the tops of the precipices. See *Mount* BLANC.

AVALON, a ſmall but ancient city of Burgundy in France, about 500 paces long and 300 broad. E. Long. 3. 5. N. Lat. 47. 38.

AVANIA, in the Turkiſh legiſlature, a fine for crimes and on deaths, paid to the governor of the place. In the places wherein ſeveral nations live together under a Turkiſh governor, he takes this profitable method of puniſhing all crimes among the Chriſtians or Jews, unleſs it be the murder of a Turk.

AVARICUM, an ancient town of the Bituriges in Gallia Celtica, ſituated on the rivulet Avara, in a very fertile ſoil (Cæſar). Now *Bourges* in Berry. E. Long. 2. 30. N. Lat. 47. 10.

AVAST, in the ſea-language, a term requiring to ſtop, or to ſtay.

AVAUNCHERS, among hunters, the ſecond branches of a deer's horns.

AUBAGNE, a town of Provence in France, ſituated on the river Veaune, on the road from Marſeilles to Toulon. The ſtates ſometimes hold their ſeſſions at this place. E. Long. 5. 52. N. Lat. 43. 17.

AUBAINE, in the cuſtoms of France, a right veſted in the king of being heir to a foreigner that dies within his dominions.

By this right the French king claims the inheritance of all foreigners that die within his dominions, notwithſtanding of any teſtament the deceaſed could make. An ambaſſador is not ſubject to the right of aubaine; and the Swiſs, Savoyards, Scots, Portugueſe, and citizens of the United States of North-America, are alſo exempted, being deemed natives and regnicoles.

AUBENAS, a town of Languedoc in France, ſituated on the river Ardeſche, at the foot of the mountains called the *Cevennes*, E. Long. 4. 32. N. Lat. 44. 40.

AUBENTON, a town of Picardy in France, ſituated on the river Aube. E. Long. 4. 25. N. Lat. 49. 51.

AUBETERRE, a town of France in the Angoumois, on the river Dronne. E. Long. 0. 10. N. Lat. 45. 15.

AUBIGNE, a town of Berry in France, ſituated on the river Verre, in a flat agreeable country. It is ſurrounded with high ſtrong walls, wide ditches, and high counterſcarps. The caſtle is within the town, and is very handſome. E. Long. 2. 20. N. Lat. 47. 29.

AUBIGNY, a dukedom in France belonging to the Dukes of Richmond in England; confirmed to the preſent duke, and regiſtered in the parliament of Paris 1777.

AUBIN DU COMIER, a town of Britanny in France. W. Long. 1. 15. N. Lat. 48. 15.

AUBIN, in horſemanſhip, a broken kind of gate, between an amble and a gallop, accounted a defect.

AUBONNE, a town of Switzerland, in the canton of Bern. E. Long. 5. 54. N. Lat. 48. 30. It is ſituated near a river of the ſame name, ſeven miles north of the lake of Geneva, upon an eminence which has a gentle declivity, at the foot of which runs the river with an impetuous torrent. The town is built in the form of an amphitheatre; on the upper part of which ſtands a very handſome caſtle with a fine court, and a portico ſupported by pillars of a ſingle ſtone each; above there is a covered gallery that runs round the court; and as the caſtle ſtands high, there is a moſt delightful proſpect, not only of the town and neighbouring fields, but of the whole lake of Geneva and the land that ſurrounds it. At Thonen, in Savoy on the other ſide of the lake, is a town covered with tin, which makes a glittering appearance when the ſun is in a certain poſition; and the caſtle of Aubonne has likewiſe a tower of the ſame kind, which at certain hours makes a ſimilar appearance to the Savoyards. The balliage of Aubonne contains ſeveral villages, which are moſtly at the foot of the mountain Jura. In one part of this mountain there is a very deep cave, wherein thoſe that go down find a natural and perpetual ice-houſe. At the bottom is heard a great noiſe like that of a ſubterraneous river, which is ſuppoſed to be that of the river Aubonne, becauſe it firſt appears, with ſeveral ſources, about 100 paces from the foot of that mountain.

Aubrey || Auch.

AUBREY (John), a famous Engliſh antiquary, deſcended from an ancient family in Wiltſhire, was born in 1626. He made the hiſtory and antiquities of England his peculiar ſtudy and delight; and contributed conſiderable aſſiſtance to the famous *Monaſticon Anglicanum*. He ſucceeded to ſeveral good eſtates; but law-ſuits and other misfortunes conſumed them all, ſo that he was reduced to abſolute want. In this extremity he found a valuable benefactreſs in the Lady Long of Draycot in Wilts, who gave him an apartment in her houſe, and ſupported him to his death, which happened about the year 1700. He was a man of capacity, learning, and application, a good Latin poet, an excellent naturaliſt, but ſomewhat credulous, and tinctured with ſuperſtition. He left many works behind him. He wrote, 1. Miſcellanies. 2. A Perambulation of the county of Surry, in five volumes, octavo. 3. The Life of Mr Hobbes of Malmſbury. 4. *Monumenta Britannica*, or a diſcourſe concerning Stonehenge, and Roll-Rich ſtones in Oxfordſhire. 5. *Architectonica Sacra*; and ſeveral other works ſtill in manuſcript.

AUBURN, a market-town in Wiltſhire, in England. W. Long. 1. 20. N. Lat. 53. 20.

AUBUSSON, a ſmall town of France, in the province of La Marche, and the government of the Lyonnois. Its ſituation is very irregular, on the river Creuſe, in a bottom ſurrounded with rocks and mountains. A manufacture of tapeſtry is carried on here, by which the town is rendered very populous. E. Long. 2. 15. N. Lat. 45. 58.

AUCAUGREL, the capital of the kingdom of Adel in Africa, ſeated on a mountain. E. Long. 44. 25. N. Lat. 9. 10.

AUCH, a city of France, the capital of the county of Armagnac, and the metropolis of all Gaſcony. The archbiſhop aſſumes the title of primate of Aquitain. It lies on the ſummit and declivity of a very ſteep hill, which is ſurrounded by other hills that riſe at a ſmall diſtance; and through the vale below runs a rivulet, called the *Gers*. The inhabitants are about 6000; the buildings are modern and elegant; the ſtreets, though in general narrow, yet are clean and well

Auction | Auditor.

well paved. In the centre of the city ſtands the cathedral, which is one of the moſt magnificent in France, both as to its conſtruction and the internal decorations. The painted windows are only inferior to thoſe of Gouda in Holland. The chapels are of equal beauty, and ornamented at a prodigious expence. The revenues of the ſee of Auch, amount annually to three hundred thouſand livres. The palace is a very handſome building; and its apartments are furniſhed with a voluptuous ſplendor, rather becoming a temporal than a ſpiritual prince. E. Long. 0. 40. N. Lat. 43. 40.

AUCTION, a kind of public ſale, very much in uſe for houſehold goods, books, plate, &c. By this method of ſale the higheſt bidder is always the buyer. This was originally a kind of ſale among the ancient Romans, performed by the public crier *ſub haſta, i. e.* under a ſpear ſtuck up on that occaſion, and by ſome magiſtrate, who made good the ſale by delivery of the goods.

AUDEUS, the chief of the Audeans, obtained the name of an heretic, and the puniſhment of baniſhment, for celebrating Eaſter in the manner of the Jews, and attributing an human form to the Deity. He died in the country of the Goths, about the year 370.

AUDEANISM, the ſame with anthropomorphiſm. See ANTHROPOMORPHITES.

AUDIENCE given to ambaſſadors, a ceremony obſerved in courts at the admiſſion of ambaſſadors or public miniſters to a hearing.

In England, audience is given to ambaſſadors in the preſence-chamber; to envoys and reſidents, in a gallery, cloſet, or in any place where the king happens to be. Upon being admitted, as is the cuſtom of all courts, they make three bows; after which they cover and ſit down; but not before the king is covered and ſat down, and has given them the ſign to put on their hats. When the king does not care to have them covered, and ſit, he himſelf ſtands uncovered; which is taken as a ſlight. At Conſtantinople, miniſters uſually have audience of the prime vizier.

AUDIENCE is alſo the name of a court of juſtice eſtabliſhed in the Weſt-Indies by the Spaniards, anſwering in effect to the parliament in France. Theſe courts take in ſeveral provinces, called alſo *audiences* from the names of the tribunal to which they belong.

AUDIENCE is alſo the name of an eccleſiaſtical court held by the archbiſhop of Canterbury, wherein differences upon elections, conſecrations, inſtitutions, marriages, &c. are heard.

AUDIENDO & TERMINANDO, a writ, or rather a commiſſion to certain perſons, when any inſurrection or great riot is committed in any place, for the appeaſing and puniſhment thereof.

AUDIENTES, or AUDITORES, in church-hiſtory, an order of catechumens; conſiſting of thoſe newly inſtructed in the myſteries of the Chriſtian religion, and not yet admitted to baptiſm.

AUDIT, a regular hearing and examination of an account by ſome proper officers, appointed for that purpoſe.

AUDITOR, in a general ſenſe, a hearer, or one who liſtens and attends to any thing.

Auditor | Auditory.

AUDITOR, according to the Engliſh law, is an officer of the king, or ſome other great perſon, who, by examining yearly the accounts of the under officers, makes up a general book, with the difference between their receipts and charges, and their allowances to allocations.

AUDITORS of the Receipts, is an officer of the exchequer who files the tellers bills, makes an entry of them, and gives the lord treaſurer a certificate of the money received the week before. He alſo makes debentures to every teller, before they receive any money, and takes their accounts. He keeps the black book of receipts, and the treaſurer's key of the treaſury, and ſees every teller's money locked up in the new treaſury.

AUDITORS of the Revenue, or of the exchequer, officers who take the accounts of thoſe who collect the revenues and taxes raiſed by parliament, and take the accounts of the ſheriffs, eſcheators, collectors, tenants, and cuſtomers, and ſet them down in a book, and perfect them.

AUDITORS of the Preſt and Impreſt, officers of the exchequer, who take and make up the accounts of Ireland, Berwick, the mint, and of any money impreſſed to any man for the king's ſervice. They received poundage on all accounts paſſed by them, which amounted to a prodigious ſum, eſpecially in time of war. But the office is now aboliſhed, and L. 7000 a year given to the incumbents.

AUDITORS Collegiate, Conventual, &c. officers formerly appointed in colleges, &c. to examine and paſs their accounts.

AUDITORES, in church hiſtory. See AUDIENTES.

The auditores formed one branch of the Manichean ſect, which was divided into *elect* and *auditors*; correſponding, according to ſome writers, to *clergy* and *laity*; and according to others, to the *faithful* and *catechumens* among the Catholics. By the Manichean rule, a different courſe of life was preſcribed to the elect from that of the auditors. The latter might eat fleſh, drink wine, bathe, marry, traffic, poſſeſs eſtates, bear magiſtracy, and the like; all which things were forbidden to the elect. The auditors were obliged to maintain the elect, and kneeled down to aſk their bleſſing. Beauſobre obſerves, that the elect were eccleſiaſtics, and in general ſuch as made profeſſion of obſerving certain counſels, called *evangelic*; ſuch as the clergy and Monks; and they were called the *perfect* by Theodoret. The auditors were the laity, and ſo denominated, becauſe they heard in the church whilſt others taught and inſtructed.

AUDITORIUM, in the ancient churches, was that part of the church where the audientes ſtood to hear and be inſtructed.

The auditorium was that part now called *navis eccleſiæ* *. In the primitive times, the church was ſo ſtrict in keeping the people together in that place, that the perſon who went from thence in ſermon-time was ordered by the council of Carthage to be excommunicated.

* See Navis.

AUDITORY, ſomething relating to the ſenſe of hearing.

AUDITORY, or AUDIENCE, an aſſembly of people who attend to hear a perſon that ſpeaks in public.

Auditory | Audran.

AUDITORY is alſo uſed for the bench whereon a magiſtrate or judge hears cauſes.

AUDITORY, in ancient churches. See AUDITORIUM.

AUDITORY Paſſage, (meatus auditorius), in anatomy; the entrance of the ear. See ANATOMY, p. 763, n° 141.

AUDITORY Nerves. See ANATOMY, p. 760.

AUDRAN (Claude), a French engraver, the firſt of the celebrated artiſts of that name, was the ſon of Lewis Audran, an officer belonging to the wolf-hunters in the reign of Henry IV. of France; and was born at Paris in 1592. He never made any great progreſs in the art; ſo that his prints are held in little or no eſtimation. Yet though he acquired no great reputation by his own works, it was no ſmall honour to him to be the father of three great artiſts, Germain, Claude, and Girard; the laſt of whom has immortalized the name of the family for ever. Claude Audran retired from Paris to Lyons, where he reſided, and died in 1677.

AUDRAN (Carl), a very eminent engraver, was brother to the preceding, though ſome aſſert he was only his couſin-german, and was born at Paris in 1594. In his infancy he diſcovered much taſte, and a great diſpoſition for the arts; and to perfect himſelf in engraving, which he appears to have been chiefly fond of, he went to Rome, where he produced ſeveral prints that did him great honour. At his return, he adopted that ſpecies of engraving which is performed with the graver only. He ſettled at Paris, where he died in 1674, without having ever been married. The Abbé Marolles, who always ſpeaks of this artiſt with great praiſe, attributes 130 prints to him: amongſt which, the *annunciation*, a middling-ſized plate, upright, from Annabale Carracci; and the *aſſumption*, in a circle, from Domenichino, are the moſt eſteemed. In the early part of his life he marked his prints with C, or the name of Carl, till his brother Claude publiſhed ſome plates with the initial only of his baptiſmal name; when, for diſtinction ſake, he uſed the letter K, or wrote his name Karl, with the K inſtead of the C.

AUDRAN (Germain), the eldeſt ſon of Claude, mentioned in the preceding article but one, was born in 1631 at Lyons, where his parents then reſided. Not content with the inſtructions of his father, he went to Paris, and perfected himſelf under his uncle Carl; ſo that, upon his return to Lyons, he publiſhed ſeveral prints which did great honour to his graver. His merit was in ſuch eſtimation, that he was made a member of the academy eſtabliſhed in that town, and choſen a profeſſor. He died at Lyons in 1710, and left behind him four ſons, all artiſts; namely, Claude, Benoiſt, John, and Louis.

AUDRAN (Claude), the ſecond of this name, and ſecond ſon to Claude abovementioned, was born at Lyons in 1639, and went to Rome to ſtudy painting, where he ſucceeded ſo well, that at his return he was employed by Le Brun to aſſiſt him in the battles of Alexander, which he was then painting for the king of France. He was received into the Royal Academy in the year 1675, and died unmarried at Paris in 1684. His virtues, (ſays Abbé Fontenai) were as praiſe-worthy as his talents were great. M. Heineken mentions this artiſt as an engraver, without ſpecifying any of his works in that line. Audran.

AUDRAN (Girard, or Gerard), the moſt celebrated artiſt of the whole family of the Audrans, was the third ſon of Claude Audran mentioned in a preceding article, and born at Lyons, in 1640. He learned from his father the firſt principles of deſign and engraving; and following the example of his brother, he left Lyons and went to Paris, where his genius ſoon began to manifeſt itſelf. His reputation there brought him to the knowledge of Le Brun, who employed him to engrave the *battle of Conſtantine*, and the *triumph* of that emperor; and for theſe works he obtained apartments at the Gobelins. At Rome, whither he went for improvement, he is ſaid to have ſtudied under Carlo Maratti, in order to perfect himſelf in drawing; and in that city, where he reſided three years, he engraved ſeveral fine plates. M. Colbert, that great encourager of the arts, was ſo ſtruck with the beauty of Audran's works while he reſided at Rome, that he perſuaded Louis XIV. to recall him. On his return, he applied himſelf aſſiduouſly to engraving; and was appointed engraver to the king, from whom he received great encouragement. In the year 1681 he was named counſellor of the Royal Academy; and died at Paris in 1703. He had been married; but left no male iſſue behind him.

The great excellency of this artiſt above that of any other engraver was, that though he drew admirably himſelf, yet he contracted no manner of his own; but tranſcribed on copper ſimply, with great truth and ſpirit, the ſtyle of the maſter whoſe pictures he copied. On viewing his prints you loſe ſight of the engraver, and naturally ſay, it is Le Brun, it is Pouſſin, it is Mignard, or it is Le Sueur, &c. as you turn to the prints which he engraved from thoſe maſters. Let any one examine the *battles* above-mentioned from Le Brun, the *preſervation of the young Pyrrhus* from Nicholas Pouſſin, the *peſt* from Mignard, and the *martyrdom of St Lawrence* from Le Sueur, and then judge candidly of the truth of this obſervation. The following judicious obſervations by the Abbé Fontenai, taken chiefly from M. Baſan, with ſome ſmall variation and additions, will fully illuſtrate the merits of Gerard Audran. "This ſublime artiſt, far from conceiving that ſervile arrangement of ſtrokes, and the too frequently cold and affected clearneſs of the graver, were the great eſſentials of hiſtorical engraving, gave worth to his works by a bold mixture of free hatchings and dots, placed together apparently without order, but with an inimitable degree of taſte; and has left to poſterity moſt admirable examples of the ſtyle in which grand compoſitions ought to be treated. His greateſt works, which have not a very flattering appearance to the ignorant eye, are the admiration of true connoiſſeurs and perſons of fine taſte. He acquired the moſt profound knowledge of the art by the conſtant attention and ſtudy which he beſtowed upon the ſcience of deſign, and the frequent uſe he made of painting from nature. This great man always knew how to penetrate into the genius of the painter he copied from; often improved upon, and ſometimes even ſurpaſſed him. Without exception, he was the moſt celebrated engraver that ever exiſted in the hiſto- Strutt's Dictionary.

Audran. rical line. We have ſeveral ſubjects which he engraved from his own deſigns, that manifeſted as much taſte as character and facility. But, in the *battles of Alexander*, he ſurpaſſed even the expectations of Le Brun himſelf." Theſe conſiſt of three very large prints, length-ways, each conſiſting of four plates, which join together, from Le Brun, namely, *the paſſage of the Granicus; the battle of Arbela; Porus brought to Alexander*, after his defeat.—To this ſet are added two more large prints, length-ways, on two plates each, alſo from Le Brun, as follow: *Alexander entering the tent of Darius*; and *The Triumphal entry of Alexander into Babylon*. The former was engraved by Girard Edelink, and the latter by Girard Audran. It is to be remarked of all theſe plates, that thoſe impreſſions are generally moſt eſteemed which have the name of Goyton the printer marked upon them.—The *Peſt*, from Peter Mignard, a large plate, length-ways, alſo deſerves particular notice. In the firſt impreſſions, the figure in the clouds is Juno with her peacock behind her; in the latter, the peacock is obliterated, and the wings of an angel are added to the figure.

AUDRAN (Benoit), the ſecond ſon of Germain Audran, was born at Lyons, in 1661, where he learned the firſt principles of deſign and engraving under the inſtruction of his father. But ſoon after going to Paris, his uncle Girard Audran took him under his tuition; and Benoit ſo greatly profited by his inſtructions, that though he never equalled the ſublime ſtyle of his tutor, yet he deſervedly acquired great reputation. Nay, the Abbé Fontenai adds this eulogium: "We admire in his works a ſhare of thoſe beauties which we find in the engravings of the illuſtrious Girard." He was honoured with the appellation of the king's engraver, and received the royal penſion. He was made an academician, and admitted into the council in 1715. He died unmarried at Louzouer, where he had an eſtate, in 1721. His manner was founded on the bold clear ſtyle of his uncle. His outlines were firm and determined; his drawing correct; the heads of his figures are in general very expreſſive; and the other extremities well marked. His works, when compared with thoſe of his uncle, appear to want that mellowneſs and harmony which are ſo conſpicuous in the latter; they are more dry; and the round dots with which he finiſhes his fleſh upon the lights are often too predominant. In his moſt finiſhed plates, we find the mechanical part of the engraving extremely neat, and managed with great taſte and judgment. Among his neateſt prints may be reckoned that which repreſents *Alexander ſick*, drinking from the cup which his phyſician preſents to him; a circular plate, from Le Sueur.

AUDRAN (John), the third ſon of Germain Audran, was born at Lyons in 1667; and, after having received inſtructions from his father, went to Paris to perfect himſelf in the art of engraving under his uncle Girard Audran. At the age of 20 years, the genius of this great artiſt begun to diſplay itſelf in a ſurpriſing manner; and his future ſucceſs was ſuch, that in 1707, he obtained the title of engraver to the king, and had a penſion allowed him by his majeſty, with apartments in the Gobelins; and the following year he was made a member of the Royal Academy. He was 80 years of age before he quitted the graver; and near 90 when he died at his apartments aſſigned him by the king. He left three ſons behind him; one of whom was alſo an engraver, as we ſhall ſee below. Audran I Avellino.

"The moſt maſterly and beſt prints of this artiſt (in Mr Strutt's opinion) are thoſe which are not ſo pleaſing to the eye at firſt ſight. In theſe the etching conſtitutes a great part; and he has finiſhed them in a bold rough ſtyle. The ſcientific hand of the maſter appears in them on examination. The drawing of the human figure, where it is ſhewn, is correct. The heads are expreſſive and finely finiſhed; the other extremities well marked. He has not, however, equalled his uncle. He wants that harmony in the effect; his lights are too much and too equally covered; and there is not ſufficient difference between the ſtyle in which he has engraved his back grounds and his draperies. This obſervation refers to a fine print by him of Athaliah, and ſuch as he engraved in that ſtyle. At other times he ſeems almoſt to have quitted the point, and ſubſtituted the graver. But here I think he has not ſo well ſucceeded. The effect is cold and ſilvery: ſee, for example, the *Andromache* from Sylveſtre. One of his beſt finiſhed prints, in this neat ſtyle, ſeems to me to be *Cupid* and *Pſyche* from Ant. Coypel."

AUDRAN (Louis), the laſt ſon of Germain Audran, was born at Lyons in 1670; from whence he went to Paris, after the example of his brothers, to complete his ſtudies in the ſchool of his uncle Girard. He died ſuddenly at Paris in 1712, before he had produced any great number of prints by his own hand. He aſſiſted, it is preſumed, his brothers in their more extenſive works. Among the moſt eſteemed prints by this artiſt are *the ſeven acts of mercy*, on ſeven middling-ſized plates, length-ways, from Sebaſtian Bourdon.

AUDRAN (Benoit), the ſecond engaver of that name, was the ſon of John Audran, and nephew to the former Benoit; and was alſo eſtabliſhed at Paris. He engraved but a few plates. It is neceſſary, however, to be careful not to confound him with his uncle. But a little attention will eaſily prevent this miſtake; for the ſecond Benoit is vaſtly inferior to the firſt in point of merit. We have ſome few portraits by this artiſt; and among other plates, *the deſcent from the croſs*, from a picture of Pouſſin.

AVEIRO, a conſiderable city of Portugal, ſeated near the head of a ſmall gulf formed by the tide at the mouth of the river Vouga. This river forms a ſmall haven with a bar, over which veſſels may paſs that do not draw above eight or nine feet water. The city ſtands in a long plain, well watered, and very fertile. This plain is nine miles broad, from Porto to Coimbro; and is bounded on the eaſt by a chain of mountains called *Sara d' Alcoba*, which reach from the one town to the other. Near this city there is ſalt made in ſufficient quantity to ſerve two or three provinces. Here is a remarkable nunnery, where none are received but the daughters of the ancient nobility. The inhabitants of Aveiro have the ſingular privilege, that no ſtranger whatever can paſs a night there without leave of the magiſtrate. W. Long. 9. 8. N. Lat. 40. 30.

AVELLANE, in heraldry, a croſs, the quarters of which ſomewhat reſemble a filbert-nut. Sylvanus Morgan ſays, that it is the croſs which enſigns the mound of authority, or the ſovereign's globe.

AVELLINO, a city of Italy, in the kingdom of Naples, with a biſhop's ſee. It was almoſt ruined by an

Avellino
Avena.

an earthquake in 1694. It is, however, at preſent a pretty conſiderable place, extending a mile in length down the declivity of a hill, with ugly ſtreets but tolerable houſes. The churches have nothing to recommend them, being crowded with monſtrous ornaments in a barbarous ſtyle, which the Neapolitans ſeem to have borrowed from the Spaniards. The cathedral is a poor building, in a wretched ſituation, with little to attract the eye. The good people here need not run to Naples to ſee the blood of St. Januarius; for they have a ſtatue of St Lawrence, with a phial of his blood, which for eight days in Auguſt entertains them with a ſimilar miraculous liquefaction. Their only edifice of note is a public granary, of the Compoſite order, adorned with antique ſtatues, and a very elegant bronze one of Charles II. of Spain, while a boy, caſt by Cavalier Coſimo. The number of inhabitants amounts to 8000, ſome ſay 10,000. The biſhop's revenue is about 6000 ducats (L. 1125) a-year. The magiſtracy conſiſts of a Syndic and four Eletti, all annual; which offices are engroſſed by a certain number of families of ſome diſtinction, that neither intermarry nor aſſociate with the reſt of the burghers. There is a conſiderable manufacture of cloth here of various qualities and colours, but chiefly blue. Many wealthy merchants have a concern in this buſineſs, ſome with a capital of eighty thouſand ducats (L. 15,000). The poor women who ſpin the wool muſt work very hard to earn above four grana a-day. The ſecond article of trade is maccaroni and paſte of many kinds, which being of an excellent quality, are in high repute all over the country. Wooden chairs are alſo made and ſold here in great quantities. Avellino abounds with proviſions of every ſort; each ſtreet is ſupplied with wholeſome water; the wine is but indifferent. The ſoil of this diſtrict, which conſiſts chiefly of volcanic ſubſtances, produces little corn, but fruit in abundance, of which the apple is deſervedly held in great eſteem. The moſt profitable, however, of all its fruit-trees is the hazel. Nut buſhes cover the face of the valley, and in good years bring in a profit of ſixty thouſand ducats (L. 11,250). The nuts are moſtly of the large round ſpecies of filbert, which we call *Spaniſh*. Theſe buſhes were originally imported into Italy from Pontus, and known among the Romans by the appellation of *Nux Pontica*, which in proceſs of time was changed into that of *Nux Avellana*, from the place where they had been propagated with the greateſt ſucceſs. The proprietors plant them in rows, and by dreſſing, form them into large buſhes of many ſtems. Every year they refreſh the roots with new earth, and prune off the ſtraggling ſhoots with great attention.

AVE-MARIA, the angel Gabriel's ſalutation of the Virgin Mary, when he brought her the tidings of the incarnation.—It is become a prayer or form of devotion in the Romiſh church. Their chaplets and roſaries are divided into ſo many ave-marias, and ſo many pater-noſters, to which the Papiſts aſcribe a wonderful efficacy.

AVENA, OATS: A genus of the digynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 4th order, *Gramina*. The calyx has a double valve, and the awn on the back is contorted. The ſpecies are 13; ſix of them natives of Britain: *viz.* 1. The nuda, or naked oats. 2. The ſatua, or bearded oat-graſs. 3. The pratenſis, or meadow oat-graſs. 4. The pubeſcens, or rough oat-graſs. 5. The elatior, or tall oat-graſs. 6. The flaveſcens, or yellow oat-graſs. It is remarkable, that the native place of the ſativa, or common oat, cultivated in our fields, is almoſt totally unknown. Anſon ſays, that he obſerved it growing wild or ſpontaneouſly in the iſland of Juan Fernandez. But a vague obſervation from an author of that kind is not to be depended on.—For the culture, ſee AGRICULTURE, n° 137.

Avenaceous
Aventine.

Oats are an article of the materia medica. Gruels made from them have a kind of ſoft mucilaginous quality; by which they obtund acrimonious humours, and prove uſeful in inflammatory diſeaſes, coughs, hoarſeneſs, and exulcerations of the fauces.

AVENACEOUS, ſomething belonging to or partaking of the nature of oats.

AVENAGE, in law, a certain quantity of oats paid by a tenant to a landlord, inſtead of rent or ſome other duties.

AVENCHE, an ancient city of Switzerland, in the canton of Bern, formerly the capital of all Switzerland, but now ſhows its former greatneſs only by its ruins. E. Long. 7. 7. N. Lat. 46. 50.

AVENES, a ſmall but ſtrong town in French Flanders, in the county of Hainalt, ſeated on the river Theſpes. It contains about 2500 inhabitants; but the houſes are wretchedly built, and the ſtreets irregular. It was fortified by M. Vauban in a ſtrong regular manner. About this place are a prodigious number of white ſtones proper for building, and uſed by ſculptors for ſtatues: they are known by the name of *Stones of Avenes*. E. Long. 3. 40. N. Lat. 50. 10.

AVENIO, an ancient town of the Cavares, and one of the moſt opulent in Gallia Narbonenſis; now *Avignon*, in Provence. See AVIGNON.

AVENOR, an officer belonging to the king's ſtables, who provides oats for the horſes. He acts by warrant from the maſter of the horſe.

AVENS, in botany. See CARIOPHILLUS.

AVENTINE (John, author of the Annals of Bavaria, was born of mean parentage, in the year 1466, at Abenſperg in the country juſt named. He ſtudied firſt at Ingoldſtadt, and afterwards in the univerſity of Paris. In 1503, he privately taught eloquence and poetry at Vienna; and in 1507, he publicly taught Greek at Cracow in Poland. In 1509, he read lectures on ſome of Cicero's pieces at Ingoldſtadt; and in 1512, was appointed to be preceptor to prince Lewis and prince Erneſt, ſons of Albert the Wiſe, duke of Bavaria; and travelled with the latter of thoſe two princes. After this he undertook to write the Annals of Bavaria, being encouraged by the dukes of that name, who ſettled a penſion upon him, and gave him hopes that they would defray the charges of the book. This work, which gained its author great reputation, was firſt publiſhed in 1554, by Jerome Zeiglerus, profeſſor of poetry in the univerſity of Ingoldſtadt; and afterwards at Braſil in 1580, by Nicholas Ciſner. An affront which Aventine received in the year 1529, ſtuck by him all the reſt of his life: he was forcibly taken out of his ſiſter's houſe at Abenſperg, and hurried to a jail; the true cauſe of which violence was never known: but it would probably have been carried to a much greater length, had not the Duke of Bavaria interpoſed, and

taken

Aventinus
1
Avenue.

taken this learned man into his protection. Mr Bayle remarks, that the incurable melancholy which from this time poſſeſſed Aventine, was ſo far from determining him to lead a life of celibacy, as he had done till he was 64, that it induced him perhaps to think of marrying. The violence of his new paſſion was not, however, ſo great, but that it ſuffered him to adviſe with two of his friends, and conſult certain paſſages of the bible relative to marriage. The reſult was, that it was beſt for him to marry; and having already loſt too much time, conſidering his age, he took the firſt woman he met with, who happened to be his own maid, ill-tempered, ugly, and extremely poor. He died in 1534, aged 68; leaving one daughter, who was then but two months old. He had a ſon, who died before.

AVENTINUS MONS, one of the ſeven hills on which ancient Rome ſtood. The origin of the name *Aventinus* is uncertain: but this hill was alſo called *Murcius*, from Murcia the goddeſs of ſloth, who had a little chapel there; and *Collis Dianæ*, from the temple of Diana; likewiſe *Remonius*, from Remus, who wanted to build the city and who was buried there. It was taken within the compaſs of the city by Ancus Marcius. To the eaſt it had the city walls; to the ſouth the Campus Figulinus; to the weſt, the Tiber; and to the north, Mons Palatinus, in circuit two miles and a quarter.

AVENTURE, in law-books, means a miſchance cauſing the death of a perſon without felony.

AVENUE, in gardening, a walk planted on each ſide with trees, and leading to an houſe, garden-gate, wood, &c. and generally terminated by ſome diſtant object.

All avenues that lead to a houſe ought to be at leaſt as wide as the whole front of the houſe, if wider they are better ſtill; and avenues to woods and proſpects ought not to be leſs than 60 feet wide. The trees ſhould not be planted nearer to one another than 35 feet, eſpecially if they are trees of a ſpreading kind; and the ſame ought to be the diſtance, if they are for a regular grove.

The trees moſt proper for avenues with us, are the Engliſh elm, the lime, the horſe-cheſnut, the common cheſnut, the beach, and the abele. The Engliſh elm will do in all grounds, except ſuch as are very wet and ſhallow; and this is preferred to all other trees, becauſe it will bear cutting, heading, or lopping in any manner, better than moſt others. The rough or ſmooth Dutch elm is approved by ſome, becauſe of its quick growth; this is a tree which will bear removing very well, it is alſo green almoſt as ſoon as any plant whatever in ſpring, and continues ſo as long as any, and it makes an incomparable hedge, and is preferable to all other trees for lofty eſpaliers. The lime is valued for its natural growth and fine ſhade. The horſe-cheſnut is proper for all places that are not too much expoſed to rough winds. The common cheſnut will do very well in a good ſoil; and riſes to a conſiderable height, when planted ſomewhat cloſe; though, when it ſtands ſingle, it is rather inclined to ſpread than to grow tall. The beech is a beautiful tree, and naturally grows well with us in its wild ſtate; but it is leſs to be choſen for avenues than the before-mentioned, becauſe it does not bear tranſplanting well, but it is very ſubject to miſcarry. Laſtly, the abele is fit for any ſoil, and is the quickeſt grower of any foreſt-tree. It ſeldom fails in tranſplanting; and ſucceeds very well in wet ſoils, in which the others are apt to fail. The oak is but little uſed for avenues, becauſe of its ſlow growth.

Avenzoar.

The old method of planting avenues was with regular rows of trees, and this has been always kept to till of late: but we have now a much more magnificent way of planting avenues; this is by ſetting the trees in clumps, or platoons, making the opening much wider than before, and placing the clumps of trees at about 300 feet diſtant from one another. In each of theſe clumps there ſhould be planted either ſeven or nine trees; but it is to be obſerved, that this is only to be practiſed where the avenue is to be of ſome conſiderable length, for in ſhort walks this will not appear ſo ſightly as ſingle rows of trees. The avenues made by clumps are fitteſt of all for parks. The trees in each clump ſhould be planted about 30 feet aſunder; and a trench ſhould be thrown up round the whole clump, to prevent the deer from coming to the trees to bark them.

AVENZOAR, ABU MERWAN ABDALMALEC EBN ZOHR, an eminent Arabian phyſician, flouriſhed about the end of the eleventh or the beginning of the twelfth century. He was of noble deſcent, and born at Seville, the capital of Andaluſia, where he exerciſed his profeſſion with great reputation. His grandfather and father were both phyſicians. The large eſtate he inherited from his anceſtors, ſet him above practiſing altogether for gain: he therefore took no fees from the poor, or from artificers, though he refuſed not the preſents of princes and great men. His liberality was extended even to his enemies; for which reaſon he uſed to ſay, that they hated him not for any fault of his, but rather out of envy. Dr Friend writes, that he lived to the age of 135; that he began to practiſe at 40, or (as others ſay) at 20; and had the advantage of a longer experience than almoſt any one ever had, for he enjoyed perfect health to his laſt hour. He left a ſon, known alſo by the name of *Ebn Zohr*, who followed his father's profeſſion, was in great favour with Al Manzûr emperor of Morocco, and wrote ſeveral treatiſes of phyſic.

Avenzoar was cotemporary with Averroes, who, according to Leo Africanus heard the lectures of the former, and learned phyſic of him; this ſeems the more probable, becauſe Averroes more than once gives Avenzoar a very high and deſerved encomium, calling him *admirable*, *glorious*, *the treaſure of all knowledge*, and *the moſt ſupreme in phyſic from the time of Galen to his own*. Avenzoar, notwithſtanding, is by the generality of writers reckoned an empiric: But Dr Friend obſerves, that this character ſuits him leſs than any of the reſt of the Arabians. "He was bred," continues that author, "in a phyſical family, his father and grandfather being both practitioners, whom he always remembers with great gratitude and honour. We have his own teſtimony that he had a regular education; and that he not only learned what properly belongs to a phyſician, but, out of a great deſire of knowledge, every thing beſides which relates to pharmacy or ſurgery." Dr Friend afterwards obſerves, "that he was averſe to quackery, and rejects the idle ſuperſtitions of aſtrologers; and throughout all his work profeſſes himſelf

Average | Avernus.

ſelf ſo much of the dogmatical or rational ſect, which was directly oppoſite to the empirical, that he has a great deal of reaſoning about the cauſes and ſymptoms of diſtempers; and as in his theory he chiefly, if not only, follows Galen, ſo he quotes him upon all occaſions, oftener than the reſt of the Arabians do. Notwithſtanding he is ſo Galenical, there are ſeveral particulars in him which ſeldom or never occur in other authors; and there are ſome caſes which he relates from his own experience, which are worth peruſing." He wrote a book entitled, *Tayaſſir fi'lmadáwât w'altadbîr*, i. e. "The method of preparing medicines and diet:" which is much eſteemed. This work was tranſlated into Hebrew, in the year of Chriſt 1280, and thence into Latin by Paravicius, whoſe verſion has had ſeveral editions. The author added a ſupplement to it, under the title of *Jâmé*, or *a Collection*. He alſo wrote a treatiſe *Fi'ladwiyat wa'laughdiyat*, i. e. "Of Medicines and Food;" wherein he treats of their qualities.

AVERAGE, in commerce, ſignifies the accidents and misfortunes which happen to ſhips and their cargoes, from the time of their loading and ſailing to their return and unloading; and is divided into three kinds. 1. The ſimple or particular average, which conſiſts in the extraordinary expences incurred for the ſhip alone, or for the merchandizes alone. Such is the loſs of anchors, maſts, and rigging, occaſioned by the common accidents at ſea; the damages which happen to merchants by ſtorm, prize, ſhipwreck, wet, or rotting; all which muſt be borne and paid by the thing which ſuffered the damage. 2. The large and common average, being thoſe expences incurred, and damages ſuſtained, for the common good and ſecurity both of the merchandizes and veſſels, conſequently to be borne by the ſhip and cargo, and to be regulated upon the whole. Of this number are the goods or money given for the ranſom of the ſhip and cargo, things thrown overboard for the ſafety of the ſhip, the expences of unloading for entering into a river or harbour, and the proviſions and hire of the ſailors when the ſhip is put under an embargo. 3. The ſmall averages, which are the expences for towing and piloting the ſhip out of or into harbours, creeks or rivers, one-third of which muſt be charged to the ſhip, and two-thirds to the cargo.

AVERAGE is more particularly uſed for a certain contribution that merchants make proportionably to their loſſes, who have had their goods caſt into the ſea in the time of a tempeſt. It alſo ſignifies a ſmall duty which thoſe merchants, who ſend goods in another man's ſhip, pay to the maſter for his care of them over and above the freight. Hence it is expreſſed in the bills of lading, paying ſo much freight for the ſaid goods, with primage and *average* accuſtomed.

AVERDUPOIS. See AVOIRDUPOIS.

AVERNUS, a lake of Campania in Italy, near Baiæ, famous among the ancients for its poiſonous qualities. It is deſcribed by Strabo as lying within the Lucrine bay, deep and darkſome, ſurrounded with ſteep banks that hang threatening over it, and only acceſſible by the narrow paſſage through which you ſail in. Black aged groves ſtretched their boughs over the watry abyſs, and with impenetrable foliage excluded almoſt every ray of wholeſome light; mephitic vapours aſcending from the hot bowels of the earth, being denied free paſſage to the upper atmoſphere, floated along the ſurface in poiſonous miſts. Theſe circumſtances produced horrors fit for ſuch gloomy deities; a colony of Cimerians, as well ſuited to the rites as the place itſelf, cut dwellings in the boſom of the ſurrounding hills, and officiated as prieſts of Tartarus. Superſtition always delighting in dark ideas, early and eagerly ſeized upon this ſpot, and hither ſhe led her trembling votaries to celebrate her diſmal orgies; here ſhe evoked the manes of departed heroes—here ſhe offered ſacrifices to the gods of hell, and attempted to dive into the ſecrets of futurity. Poets enlarged upon the popular theme, and painted its awful ſcenery with the ſtrongeſt colours of their art. Homer brings Ulyſſes to Avernus, as to the mouth of the infernal abodes; and in imitation of the Grecian bard, Virgil conducts his hero to the ſame ground. Whoever ſailed thither, firſt did ſacrifice; and endeavoured to propitiate the infernal powers, with the aſſiſtance of ſome prieſts who attended upon the place, and directed the myſtic performance. Within, a fountain of pure water broke out juſt over the ſea, which was fancied to be a vein of the river Styx; near this fountain was the oracle, and the hot waters frequent in thoſe parts were ſuppoſed to be branches of the burning Phlegethon. The poiſonous effluvia from this lake were ſaid to be ſo ſtrong, that they proved fatal to birds endeavouring to fly over it. Virgil aſcribes the exhalation not to the lake itſelf, but to the cavern near it, which is called *Avernus*, or *Cave of the Sibyl*, and through which the poets feigned a deſcent to hell. Hence the proper name of the lake is *Lacus Averni*, the "lake near the cavern," as it is called by ſome ancient authors. Avernus.

The holineſs of theſe ſhades remained unimpeached for many ages: Hannibal marched his army to offer incenſe at this altar; but it may be ſuſpected he was led to this act of devotion rather by the hopes of ſurpriſing the garriſon of Puteoli, than by his piety. After a long reign of undiſturbed gloom and celebrity, a ſudden glare of light was let in upon Avernus; the horrors were diſpelled, and with them vaniſhed the ſanctity of the lake; the axe of Agrippa brought its foreſt to the ground, diſturbed its ſleepy waters with ſhips, and gave room for all its malignant effluvia to eſcape. The virulence of theſe exhalations, as deſcribed by ancient authors, has appeared ſo very extraordinary, that modern writers, who know the place in a cleared ſtate only, charge theſe accounts with exaggeration: but Mr Swinburn thinks them entitled to more reſpect; for even now, he obſerves, the air is feveriſh and dangerous, as the jaundiced faces of the vine-dreſſers, who have ſucceeded the Sibyls and the Cimmerians in the poſſeſſion of the temple, moſt ruefully teſtify. Boccaccio relates, that during his reſidence at the Neapolitan court, the ſurface of this lake was ſuddenly covered with dead fiſh, black and ſinged, as if killed by ſome ſubaqueous eruption of fire.

At preſent the lake abounds with tench; the Lucrine with eels. The change of fortune in theſe lakes, is ſingular: In the ſplendid days of imperial Rome the Lucrine was the choſen ſpot for the brilliant parties of pleaſure of a voluptuous court; now, a ſlimy bed of ruſhes covers the ſcattered pools of this once beau-

Averrhoa. beautiful ſheet of water; while the once duſky Avernus is clear and ſerene, offering a moſt alluring ſurface and charming ſcene for ſimilar amuſements. Oppoſite to the temple is a cave uſually ſtyled the Sybil's grotto; but apparently more likely to have been the mouth of a communication between Cuma and Avernus, than the abode of a propheteſs; eſpecially as the ſybil is poſitively ſaid by hiſtorians to have dwelt in a cavern under the Cumean citadel.

AVERRHOA in botany: A genus of the decandria order, belonging to the pentagynia claſs of plants; and in the natural method ranking under the 14th order, *Gruinales* The calyx has 5 leaves, the petals are 5, opening at top; and the apple or fruit is pentagonous, and divided into 5 cells. There are 3 ſpecies, viz. the blimbi, the carambola, and the acida, all natives of the Indies.

Phil. Tranſ. vol. 75. part 2. The ſecond of theſe, the carambola, called in Bengal the *camrue* or *camrunga*, is remarkable for poſſeſſing a power ſomewhat ſimilar to thoſe ſpecies of Mimoſa which are termed *ſenſitive plants*; its leaves, on being touched, moving very perceptibly. In the mimoſa the moving faculty extends to the branches; but from the hardneſs of the wood, this cannot be expected in the camrunga. The leaves are alternately pinnated, with an odd one; and in their moſt common poſition in the day-time are horizontal, or on the ſame plane with the branch from which they come out. On being touched, they move themſelves downward, frequently in ſo great a degree that the two oppoſite almoſt touch one another by their under ſides, and the young ones ſometimes either come into contact or even paſs each other. The whole of the leaves of one pinna move by ſtriking the branch with the nail of the finger or other hard ſubſtance; or each leaf can be moved ſingly, by making an impreſſion that ſhall not extend beyond that leaf. In this way the leaves of one ſide of the pinna may be made to move, one after another, whilſt the oppoſite continue as they were; or you may make them move alternately, or in ſhort in any order you pleaſe, by touching in a proper manner the leaf you wiſh to put in motion. But if the impreſſion, although made on a ſingle leaf, be ſtrong, all the leaves on that pinna, and ſometimes on the neighbouring ones, will be affected by it. Notwithſtanding this apparent ſenſibility of the leaf, however, large inciſions may be made in it with a pair of ſharp ſciſſars, without occaſioning the ſmalleſt motion; nay, it may even be cut almoſt entirely off, and the remaining part ſtill continue unmoved, when by touching the wounded leaf with the finger or point of the ſciſſars, motion will take place as if no injury had been offered. The reaſon of this is, that although the leaf be the oſtenſible part which moves, it is in fact entirely paſſive, and the petiolus is the ſeat both of ſenſe and action: for although the leaf may be cut in pieces, or ſqueezed with great force, provided its direction be not changed without any motion being occaſioned; yet if the impreſſion on the leaf be made in ſuch a way as to affect the petiolus, the motion will take place. When, therefore, it is wanted to confine the motion to a ſingle leaf, you either touch it ſo as only to affect its own petiolus, or without meddling with the leaf, touch the petiolus with any ſmall-pointed body, as a pin or knife. By compreſſing the univerſal petiolus near the place where a partial one comes out, the leaf moves in a few ſeconds in the ſame manner as if you had touched the partial petiolus. Averrhoa.

Whether the impreſſion be made by puncture, percuſſion, or compreſſion, the motion does not inſtantly follow: generally ſeveral ſeconds intervene, and then it is not by a jirk, but regular and gradual. Afterwards, when the leaves return to their former ſituation, which is commonly a quarter of an hour or leſs, it is in ſo ſlow a manner as to be almoſt imperceptible.

On ſticking a pin into the univerſal petiolus at its origin, the leaf next it, which is always on the outer ſide, moves firſt; then the firſt leaf on the oppoſite ſide, next the ſecond leaf on the outer, and ſo on. But this regular progreſſion ſeldom continues throughout; for the leaves on the outer ſide of the pinna ſeem to be affected both more quickly, and with more energy, than thoſe of the inner; ſo that the fourth leaf on the outer ſide frequently moves as ſoon as the third on the inner; and ſometimes a leaf, eſpecially on the inner ſide, does not move at all, whilſt thoſe above and below it are affected in their proper time. Sometimes the leaves at the extremity of the petiolus move ſooner than ſeveral others which were nearer the place where the pin was put in. On making a compreſſion with a pair of pincers on the univerſal petiolus, between any two pair of leaves, thoſe above the compreſſed part, or nearer the extremity of the petiolus, move ſooner than thoſe under it, or nearer the origin; and frequently the motion will extend upwards to the extreme leaf, whilſt below it perhaps does not go farther than the neareſt pair. If the leaves happen to be blown by the wind againſt one another, or againſt the branches, they are frequently put in motion; but when a branch is moved gently, either by the hand or the wind, without ſtriking againſt any thing, no motion of the leaves takes place.

When left to themſelves in the day-time, ſhaded from the ſun, wind, rain, or any diſturbing cauſe, the appearance of the leaves is different from that of other pinnated plants. In the laſt a great uniformity ſubſiſts in the reſpective poſition of the leaves on the pinna; but here ſome will be ſeen on the horizontal plane, ſome raiſed above it, and others fallen under it; and in an hour or ſo, without any order or regularity which can be obſerved, all theſe will have changed their reſpective poſitions.

Cutting the bark of the branch down to the wood, and even ſeparating it about the ſpace of half an inch all around, ſo as to ſtop all communication by the veſſels of the bark, does not for the firſt day affect the leaves, either in their poſition or their aptitude for motion. In a branch, which was cut through in ſuch a manner as to leave it ſuſpended only by a little of the bark no thicker than a thread, the leaves next day did not riſe ſo high as the others; but they were green and freſh, and, on being touched, moved, but in a much leſs degree than formerly.

After-ſun-ſet the leaves go to ſleep, firſt moving down ſo as to touch one another by their under ſides; they therefore perform rather more extenſive motion at night of themſelves than they can be made to do in the day-time by external impreſſions. With a convex lens the rays of the ſun may be collected on a leaf, ſo

Averroes. | Aversion.

as to burn a hole in it, without occaſioning any motion. But upon trying the experiment on the petiolus, the motion is as quick as if from ſtrong percuſſion, although the rays be not ſo much concentrated as to cauſe pain when applied in the ſame degree on the back of the hand. The leaves [illegible] very faſt from the electrical ſhock, even althou[illegible] gentle one.

AVERROES, one of the moſt [illegible]le philoſophers that ever appeared among the Arabians, flouriſhed at the end of the 11th and beginning of the 12th century. He was the ſon of the high-prieſt and chief judge of Corduba in Spain: he was educated in the univerſity of Morocco; and ſtudied natural philoſophy, medicine, mathematics, law, and divinity. After the death of his father, he enjoyed his poſts; but notwithſtanding his being exceeding rich, his liberality to men of letters in neceſſity, whether they were his friends or his enemies, made him always in debt. He was afterwards ſtripped of all his poſts, and thrown into priſon, for hereſy; but the oppreſſions of the judge who ſucceeded him, cauſed him to be reſtored to his former employments.

He died at Morocco in the year 1206. He was exceſſively fat, though he eat but once a-day. He ſpent all his nights in the ſtudy of philoſophy; and when he was fatigued, amuſed himſelf with reading poetry or hiſtory. He was never ſeen to play at any game, or to partake in any diverſion. He was extremely fond of Ariſtotle's works, and wrote commentaries on them; whence he was ſtyled, *The commentator*, by way of eminence. He likewiſe wrote a work on the whole art of phyſic, and many amorous verſes; but when he grew old, he threw theſe laſt into the fire. His other poems are loſt, except a ſmall piece, in which he ſays, "That when he was young, he acted againſt his reaſon; but that when he was in years, he followed its dictates:" upon which he utters this wiſh; "Would to God I had been born old, and that in my youth I had been in a ſtate of perfection!" As to religion, his opinions were, that Chriſtianity is abſurd; Judaiſm, the religion of children; Mahometaniſm, the religion of ſwine.

AVERROISTS, a ſect of peripatetic philoſophers, who appeared in Italy ſome time before the reſtoration of learning, and attacked the immortality of the ſoul. They took their denomination from AVERROES, the celebrated interpreter of Ariſtotle (ſee the preceding article), from whom they borrowed their diſtinguiſhing doctrine.

The Averroiſts who held the ſoul was mortal, according to reaſon or philoſophy, yet pretended to ſubmit to the Chriſtan theology, which declares it immortal. But the diſtinction was held ſuſpicious; and this divorce of faith from reaſon was rejected by the doctors of that time, and condemned by the laſt council of the Lateran under Leo X.

AVERRUNCI (DEI); certain gods, whoſe buſineſs it was, according to the Pagan theology, to avert misfortunes. Apollo and Hercules were of the number of theſe gods, among the Greeks; and Caſtor and Pollux, among the Romans.

AVERSA, a town of Italy, in the kingdom of Naples, with a biſhop's ſee. It is ſituated in a very fine plain, in E. Long. 14. 20. N. Lat. 41 0.

AVERSION, according to Lord Kames, is oppoſed to *affection*, and not to *deſire*, as it commonly is. We have an affection to one perſon; we have an averſion to another: the former diſpoſes us to do good to its object, the latter to do ill.

Averti | Augeas.

AVERTI, in horſemanſhip, is applied to a regular ſtep or motion enjoined in the leſſons. In this ſenſe they ſay *pas averte*, ſometimes *pas ecouté*, and *pas d'ecole*, which all denote the ſame. The word is mere French, and ſignifies *adviſed*.

AVES, one of the Caribbee iſlands, 451 miles ſouth of Porto Rico, with a good harbour for careening of ſhips. It is ſo called from the great number of birds that frequent it. There is another of the ſame name lying to the northward of this, in N. Lat. 15. 0.; and a third near the eaſtern coaſt of Newfoundland, in N. Lat. 50. 5.

AVES, Birds, the name of Linnæus's ſecond claſs of animals. See ZOOLOGY, nº 8. and ORNITHOLOGY.

AVESBURY, (Robert), an Engliſh hiſtorian, of whom little more is known than that he was keeper of the regiſtry of the court of Canterbury in the reign of Edward III. and conſequently that he lived in the 14th century. He wrote, *Memorabilia geſta magnifici regis Angliæ domini Edwardi tertii poſt conqueſtum, procerumque; tactis primitus quibuſdam geſtis de tempore patris ſui domini Edwardi ſecundi, quæ in regnis Angliæ, Scotiæ, et Franciæ, ac in Aquitannia et Britannia, non humana ſed Dei potentia, contigerunt, per Robertum de Aveſbury*. This hiſtory ends with the battle of Poictiers, about the year 1356. It continued in manuſcript till the year 1720, when it was printed by the induſtrious Thomas Hearne at Oxford, from a manuſcript belonging to Sir Thomas Seabright. It is now become very ſcarce.

AVEZZANO, a town of Italy in the kingdom of Naples in the Farther Abruzzo. It is built on an almoſt imperceptible declivity, one mile from the lake of Celano, to which an avenue of poplars leads from the baronnial caſtle. This edifice ſtands at a little diſtance from the town, is ſquare, and flanked with towers; it was erected by Virginio Orſini, to which family this and many other great lordſhips belonged, before they were wreſted from them in times of civil war, and transferred to the Colonnas. Avezzano was founded in 860, and contains 2700 inhabitants, and two religious communities within its walls, which are indeed in a ruinous condition. The houſes are in general mean; but there are ſome large buildings and opulent families of the claſs of gentlemen, not poſſeſſed of fees held *in capite*.

AGUE, a territory of Normandy in France, which gives title to a viſcount. It extends from Falaiſe and Argenton as far as the ſea, between the rivers Dives, Vie, and Tougues. The arable land is ſtiff, and produces but little good corn: but they ſow ſainfoin; which ſucceeds ſo well that they have five good crops ſucceſſively: they likewiſe ſow flax and hemp; and have a vaſt quantity of apples, with which they make cyder. Horſes are bred here in great numbers; and the inhabitants fatten the oxen which come from Poictou and Brittany.

AUGEAS, in fabulous hiſtory, was king of Elis, and particularly famed for his ſtable, which contained 3000 oxen, and had not been cleaned for 30 years. Hercules was deſired to clear away the filth from this ſtable in one day; and Augeas promiſed, if he per-

Augment | Augſburg.

formed it, to give him a tenth part of the cattle. This taſk Hercules is ſaid to have executed by turning the courſe of the river Alpheus through the ſtable; when Augeas refuſing to ſtand by his engagement, Hercules ſlew him with his arrows, and gave his kingdom to Phyleus his ſon, who had ſhown an abhorrence of his farther's inſincerity.

AUGMENT, in grammar, an accident of certain tenſes of Greek verbs, being either the prefixing of a ſyllable, or an increaſe of the quantity of the initial vowels.

AUGMENTATION, in a general ſenſe, is the act of adding or joining ſomething to another with a deſign to render it large.

AUGMENTATION is alſo uſed for the additament or thing added.

AUGMENTATION was alſo the name of a court erected 27 Hen. VIII. ſo called from the augmentation of the revenues of the crown, by the ſuppreſſion of religious houſes; and the office ſtill remains, wherein there are many curious records, tho' the court has been diſſolved long ſince.

AUGMENTATION, in heraldry, are additional charges to a coat-armour, frequently given as particular marks of honour, and generally borne either in the eſcutcheon or a conton; as have all the baronets of England, who have borne the arms of the province of Ulſter in Ireland.

AUGRE, or AWGRE, an inſtrument uſed by carpenters and joiners to bore large round holes; and conſiſting of a wooden handle, and an iron blade terminated at bottom with a ſteel bit.

AUGSBURG, a city of Germany, capital of the circle of Suabia, ſeated near the confluence of the Ardech and Lech, in one of the moſt beautiful plains that can be imagined. It is one of the largeſt and handſomeſt cities of the empire; but the fortifications are after the old manner, and very irregular; the ſtreets are broad and ſtraight; the houſes moſtly of timber, plaſtered and whitened without, or adorned with paintings; the reſt are of free-ſtone; the churches and fountains are generally ornamented with fine figures of braſs. Many of the churches are ſtately, and adorned within with curious workmanſhip and paintings. That part of the city erected by the noble family of the Fuggers, who are lords of the adjacent country, conſiſts of ſeveral ſtreets croſs-wiſe, containing 106 houſes: the poor people that inhabit them are maintained by an annual penſion. Its magnificent town-houſe is little inferior to that of Amſterdam, it being a vaſt ſquare ſtone-building, with a marble portico; at the top of the front, within the pediment, is a large ſpread eagle, holding a ſceptre and globe in its talons, of braſs, gilt, ſaid to weigh 2200 weight; the great portal is of a very beautiful reddiſh marble; over which is a balcony of the ſame colour, ſupported by two pillars of white marble; over the gate there are two large griffins of braſs; moſt of the rooms are wainſcotted and ceiled with very fine timber: the great hall is very magnificent, and paved with marble; it is 110 feet long, 58 broad, and 52 high, and its roof is ſupported by eight columns of red marble; the ceiling of the upper wall is of very curious workmanſhip of poliſhed aſh, conſiſting of compartments, the ſquares and pannels of which are enriched with gilded ſculptures, and filled with pictures and other ornaments; this is likewiſe ſupported by eight pillars with baſes and chapiters of braſs: the other rooms are handſomely adorned with very fine paintings. Auſburg.

In the ſquare, near the town-houſe, is the fountain of Auguſtus, which is a marble baſon, ſurrounded with iron balluſtrados [illegible] wrought: at the four corners are four braſs ſtatues as big as the life, two of which are women and two men; in the middle of the baſon is a pedeſtal, at the foot of which are four large ſphinxes ſquirting water out of their breaſts; a little above theſe are four infants holding four dolphins in their arms, which pour water out of their mouths; and over theſe infants are feſtoons of pine-apples all of braſs; upon the pedeſtal is the ſtatue of Auguſtus as large as the life. The fountain moſt remarkable next to this is that of Hercules, which is a hexagon baſon with ſeveral braſs figures, particularly Hercules engaging the hydra. Another curioſity is the ſecret gate, which was contrived to let in perſons ſafely in time of war: it has ſo many engines and diviſions with gates and keys, and apartments for guards at ſome diſtance from each other, where paſſengers are examined, that it is impoſſible for the town to be ſurpriſed this way; the gates are bolted and unbolted, opened and ſhut, by unſeen operators, inſomuch that it looks like enchantment. The water-towers are alſo very curious, of which there are three ſeated on a branch of the river Lech, which runs through the city in ſuch a torrent as to drive many mills, which work a number of pumps that raiſe the water in large leaden pipes to the top of the towers; one of theſe ſends water to the public fountains, and the reſt to near 1000 houſes in the city.

The Lutherans have a college here, which is a vaſt ſquare building, with a fine clock on the top of the front. In this there are ſeven different claſſes, a hall for public diſputations, and a theatre for dramatic repreſentation. The cathedral is a large, gloomy, Gothic building, with two ſpire ſteeples; it is adorned with paintings upon whimſical ſubjects, and has a great gate all of braſs, over which are ſeveral ſcripture paſſages well repreſented in baſſo relievo. The Jeſuits had a ſplendid college here, with a church full of gilding, painting, and carving; and a fine library. Tho' half the inhabitants are Lutherans, there are a great many Popiſh proceſſions. There are no Jews in the town, nor are they ſuffered to lie there; but they inhabit a village at about a league diſtance, and pay ſo much an hour for the liberty of trading in the daytime. The Benedictine abbey is a vaſt Gothic building, the ceiling of which is ſaid to be the higheſt in Germany, and overlooks all the reſt of the churches; it is adorned with ſeveral ſtatues, and has one very grand altar. The church of St Croix is one the handſomeſt in Augſburg for architecture, painting, ſculpture, gilding, and a fine ſpire.

The inhabitants look upon Auguſtus Cæſar as the founder of the town: it is true, that that emperor ſent a colony there; but the town was already founded, though he gave it the name of *Auguſta Vindelicorum*. Augſburg, indeed, is one of the oldeſt towns in Germany, and one of the moſt remarkable of them, as it is there and at Nuremberg that you meet with the oldeſt marks of German art and induſtry. In the 14th and 15th centuries, the commerce of this town was the

Augſburg. the moſt extenſive of any part of ſouth Germany, and contributed much to the civilization of the country by the works of art and variety of neceſſaries to the comfort and convenience of life which it was the means of introducing. Many things originated in this town which have had a great influence on the happineſs of mankind. Not to mention the many important diets of the empire held here; here, in 952, did a council confirm the order for the celibacy of prieſts; here, in 1530, was the confeſſion of faith of the Proteſtants laid before the emperor and other eſtates of Germany; and here, in 1555, was ſigned the famous treaty of peace, by which religious liberty was ſecured to Germany.

Though the Proteſtants were very powerful at Augſburg, they could not keep their ground; for the Bavarians drove them from thence: but Guſtavus Adolphus reſtored them again in 1632; ſince which time they have continued there, and ſhare the government with the Catholics. In 1703, the elector of Bavaria took the city after a ſiege of ſeven days, and demoliſhed the fortifications: however, the battle of Hochſted reſtored their liberty, which they yet enjoy under the government of their own magiſtrates, the biſhop having no temporal dominion in the city. The chapter is compoſed of perſons of quality, who are to bring proofs of their nobility. The canons have a right of electing their own biſhop, who is a ſovereign, in the ſame manner as ſeveral other of the German biſhops.

The police of the place is very good; and though the town has no territory, it has no debts. Augſburg is, however, no longer what it was. It no longer has a Fugger and a Welſer in it to lend the emperor millions. In this large and handſome town, formerly one of the greateſt trading towns in Germany, there are no merchants at preſent to be found who have capitals of more than L. 20,000. The others, moſt of whom muſt have their coaches, go creeping on with capitals of L. 3,000 or L. 4,000, and do the buſineſs of brokers and commiſſioners. Some houſes, however, carry on a little banking trade; and the way through Tyrol and Graubundten occaſions ſome little exchange between this place and Germany. After theſe brokers and doers of buſineſs by commiſſion, the engravers, ſtatuaries, and painters, are the moſt reputable of the labouring part of the city. Their productions, like the toys of Nuremberg, go every where. There are always ſome people of genius amongſt them; but the ſmall demand for their art affords them ſo little encouragement, that to prevent ſtarving they are moſtly confined to the ſmall religious works which are done elſewhere by Capuchin monks. They furniſh all Germany with little pictures for prayer books, and to hang in the citizens houſes. There is an academy of arts inſtituted here under the protection of the magiſtrates: the principle aim of which is to produce good mechanics, and preſerve the manufactures of the city.

This town, which is 9½ miles in circumference, contains, according to Mr Rieſbeck, hardly 30,000 inhabitants; but Mr Nicolai makes them about 35,000 and ſays there are 28,000 houſes.

The city has its drinking water from the river Lech, which runs at ſome diſtance from it; and the aqueducts which convey the water are much to be admired. As the court of Bavaria has it in its power to cut off this indiſpenſable neceſſary, by threatening the town with doing ſo, it often lays it under contribution. But as it has, beſides this, other means of keeping the high council in a ſtate of dependance, to ſecure itſelf from this oppreſſion, the city ſeeks the emperor's protection, upon whom it makes itſelf as dependant on the other ſide, ſo as to be indeed only a ball which both courts play with. The emperor's miniſter to the circle of Suabia generally reſides here, and by ſo doing ſecures to his court a perpetual influence. There are always Auſtrian and Pruſſian recruiting parties quartered here, and the partiality of the government to the former is very remarkable. In the war of 1756, the citizens were divided into equal parties for the two courts. The Catholics conſidered the emperor as their god, and the Proteſtants did the ſame by the king of Pruſſia. The flame of religion had almoſt kindled a bloody civil war amongſt them.—The biſhop takes his name from this town, but reſides at Dillingen. He has an income of about L. 20,000 *per annum*. As a proof of the catholiciſm of this place, the Pope throughout his whole progreſs met no where with ſuch honours as he did here. This he owed to his friends the Jeſuits, who have ſtill great influence. E. Long. 10. 58. N. Lat. 48. 24.

Augsburg Confeſſion, denotes a celebrated confeſſion of faith drawn up by Luther and Melancthon, on behalf of themſelves and other ancient reformers, and preſented in 1530 to the emperor Charles V. at the diet of Auguſta or Augſburg, in the name of the evangelic body. This confeſſion contains 28 chapters; of which the greateſt part is employed in repreſenting, with perſpicuity and truth, the religious opinions of the Proteſtants, and the reſt in pointing out the errors and abuſes that occaſioned their ſeparation from the church of Rome.

Augſburg ‖ Augury.

AUGUR, an officer among the Romans appointed to foretel future events, by the chattering, flight, and feeding, of birds. There was a college or community of them, conſiſting originally of three members with reſpect to the three Luceres, Rhamnenſes, and Tatienſes: afterwards the number was increaſed to nine, four of whom were patricians and five plebeians. They bore an augural ſtaff or wand, as the enſign of their authority; and their dignity was ſo much reſpected, that they were never depoſed, nor any ſubſtituted in their place, though they ſhould be convicted of the moſt enormous crimes. See AUGURY.

AUGURAL, ſomething relating to the augurs.—The augural inſtruments are repreſented on ſeveral ancient medals.

Augural Supper, that given by a prieſt on his firſt admiſſion into the order, called alſo by Varro *Adjicialis*.

Augural Books, thoſe wherein the diſcipline and rules of augury were laid down.

AUGURALE, the place in a camp where the general took auſpicia. This anſwered to the *Auguratorium* in the city.

AGURALE is alſo uſed in Seneca for the enſign or badge of an augur, as the *lituus*.

AUGURATORIUM, a building on the Palatine mount where public auguries were taken.

AUGURY, in its proper ſenſe, the art of foretelling future events by obſervations taken from the

Augury. chattering, ſinging, feeding, and flight of birds; though it was uſed by ſome writers in a more general ſignification, as compriſing all the different kinds of divination.

Augury was a very ancient ſuperſtition. We know from Heſiod, that huſbandry was in part regulated by the coming or going of birds; and moſt probably it had been in uſe long before his time, as aſtronomy was then in its infancy. In proceſs of time, theſe animals ſeem to have gained a greater and very wonderful authority, till at laſt no affair of conſequence, either of public or private concern, was undertaken without conſulting them. They were looked upon as the interpreters of the gods; and thoſe who were qualified to underſtand their oracles were held among the chief men in the Greek and Roman ſtates, and became the aſſeſſors of kings, and even of Jupiter himſelf. However abſurd ſuch an inſtitution as a college of Augurs may appear in our eyes, yet, like all other extravagant inſtitutions, it had in part its origin from nature. When men conſidered the wonderful migration of birds, how they diſappeared at once, and appeared again at ſtated times, and could give no gueſs where they went, it was almoſt natural to ſuppoſe, that they retired ſomewhere out of the ſphere of this earth, and perhaps approached the ethereal regions, where they might converſe with the gods, and thence be enabled to predict events. It was almoſt natural for a ſuperſtitious people to imagine this; at leaſt to believe it, as ſoon as ſome impoſtor was impudent enough to aſſert it. Add to this, that the diſpoſition in ſome birds to imitate the human voice, muſt contribute much to the confirmation of ſuch a doctrine. This inſtitution of augury ſeems to have been much more ancient than that of aruſpicy; for we find many inſtances of the former in Homer, but not a ſingle one of the latter, tho' frequent mention is made of ſacrifices in that author. From the whole of what has been obſerved, it ſeems probable, that natural augury gave riſe to religious augury, and this to aruſpicy, as the mind of man makes a very eaſy tranſition from a little truth to a great deal of error.

Stillingfleet's *Calendar of Flora.*

A paſſage in Ariſtophanes gave the hint for theſe obſervations. In the Comedy of the Birds, he makes one of them ſay this: 'The greateſt bleſſings which can happen to you, mortals, are derived from us; firſt, we ſhow you the ſeaſons, viz. Spring, Winter, Autumn. The crane points out the time for ſowing, when ſhe flies with her warning notes into Egypt; ſhe bids the ſailor hang up his rudder and take his reſt, and every prudent man provide himſelf with winter-garments. Next the kite appearing, proclaims another ſeaſon, *viz.* when it is time to ſhear his ſheep. After that the ſwallow informs you when it is time to put on ſummer clothes. We are to you, (adds the chorus), Ammon, Dodona, Apollo: for, after conſulting us, you undertake every thing; merchandize, purchaſes, marriages, &c.' Now, it ſeems not improbable, that the ſame tranſition was made in the ſpeculations of men which appears in the poet's words; and that they were eaſily induced to think, that the ſurpriſing foreſight of birds, as to the time of migration, indicated ſomething of a divine nature in them; which opinion Virgil, as an Epicurean, thinks fit to enter his proteſt againſt, when he ſays,

Haud equidem credo, quia ſit divinitus illis
Ingenium.

But to return to Ariſtophanes. The firſt part of the chorus, from whence the fore-cited paſſage is taken, ſeems, with all its wildneſs, to contain the fabulous cant, which the augurs made uſe of in order to account for their impudent impoſitions on mankind. It ſets out with a coſmogony; and ſays, That in the beginning were Chaos and Night, and Erebus and Tartarus: That there was neither water, nor air, nor ſky: That Night laid an egg, from whence, after a time, Love aroſe: That Love, in conjunction with Erebus, produced a third kind; and that they were the firſt of the immortal race, &c.

Auguſt | Auguſta.

AUGUST, (*Auguſtus*), in a general ſenſe, ſomething majeſtic, venerable, or ſacred. The appellation was firſt conferred by the Roman ſenate upon Octavius, after his being confirmed by them in the ſovereign power. It was conceived as expreſſing ſomething divine, or elevated above the pitch of mankind, being derived from the verb *augeo*, "I increaſe," *tanquam ſupra humanam ſortam auctus.* See AUGUSTUS.

AUGUST, in chronology, the eighth month of our year, containing 31 days. Auguſt was dedicated to the honour of Auguſtus Cæſar, becauſe, in the ſame month, he was created conſul, thrice triumphed in Rome, ſubdued Egypt to the Roman empire, and made an end of civil wars: being before called *Sexatilis*, or the ſixth month from March.

AUGUSTA, the capital of the ſtate of Georgia, in North America, on the river Savannah, 134 miles from the ſea, ſeated on a fine plain, it contains about 200 houſes, and from the advantage of its central ſituation between the upper and lower counties is riſing faſt into importance.

AUGUSTA, or *Auſta*, an iſland in the Adriatic ſea, on the coaſt of Dalmatia, near Raguſa, ſubject to Venice. E. Long. 17. 50. N. Lat. 42. 35.

AUGUSTA Auſciorum, a town of Aquitania. In the middle age, it took the name of the people, *Auſci*; and is now called *Auch*, the capital of Gaſcony.

AUGUSTA Emerita, a town of Luſitania on the river Anas, the capital of the province; a colony of the Emeriti, or ſuch ſoldiers as had ſerved out their legal time, were men of experience, or had received marks of favour. The colony was founded by Auguſtus; and is now called *Merida*, a city of Spain, in Eſtremadura, on the river Guadiana. See MERIDAN.

AUGUSTA Prætoria, a town and colony of Gallia Ciſalpina, and capital of the Salaſſi; ſeated at the foot of the Alps Graiæ on the Duria. Now *Auouſte* in Piedmont. See AOUSTE.

AUGUSTA Rauracorum, a town of Gallia Belgica; now a ſmall village called *Auguſt*, at the bend of the Rhine northwards, but from the ruins, which are ſtill to be ſeen, appears to have been a conſiderable colony, at the diſtance of ſix miles from Baſil to the eaſt.

AUGUSTA Sueſſonum, a town of Gallia Belgica on the Axona. Now *Soiſſons*, on the river Aiſne, in the Iſle of France. See SOISSONS.

AUGUSTA Taurinorum, a town of the Taurini at the foot of the Alps where the Duria Minor falls into the Po; now *Turin*, the capital of Piedmont.

AUGUSTA Treba, a town of the Æqui, near the ſprings of the river Anio in Italy; now *Trevi*, in Umbria, or in the eaſt of the Campagna di Roma.

Auguſta I Auguſtin.

Auguſta Trevirorum, a town of the Treviri, a people inhabiting between the Rhine and the Meuſe, but eſpecially about the Moſelle; now *Triers*, or *Treves*, in the circle of the Lower Rhine on the Moſelle.

Auguſta Vindelicorum, a town of the Licates on the Licus; called by Tacitus a noble colony of *Rhætia*; now *Augſburg*, capital of Suabia.

Auguſta Hiſtoria, is the hiſtory of the Roman emperors from the time of Adrian to Carinus, that is, from the year of our Lord 157 to 285, compoſed by ſix Latin writers, Æl. Spartianus, Julius Capitolinus, Æl. Lampridius, Vulcatius Gallicanus, Trebellius Pollio, and Flavius Vopiſcus.

AUGUSTALES, in Roman antiquity, an epithet given to the flamens or prieſts appointed to ſacrifice to Auguſtus after his deification; and alſo to the ludi or games celebrated in honour of the ſame prince on the fourth of the ides of October.

AUGUSTALIA, a feſtival inſtituted by the Romans in honour of Auguſtus Cæſar, on his return to Rome, after having ſettling peace in Sicily, Greece, Syria, Aſia, and Parthia; on which occaſion they likewiſe built an altar to him, inſcribed *Fortunæ reduci*.

AUGUSTALIS PRÆFECTUS, a title peculiar to a Roman magiſtrate who governed Egypt, with a power much like that of a proconſul in other provinces.

AUGUSTAN CONFESSION. See AUGSBURG *Confeſſion*.

AUGUSTIN, or AUSTIN, (St), the firſt archbiſhop of Canterbury, was originally a monk in the convent of St Andrew at Rome, and educated under St Gregory, afterwards Pope Gregory I. by whom he was diſpatched into Britain with 40 other monks of the ſame order, about the year 596, to convert the Engliſh Saxons to Chriſtianity. They landed in the iſle of Thanet; and having ſent ſome French interpreters to king Ethelbert with an account of their errand, the king gave them leave to convert as many of his ſubjects as they could, and aſſigned their place of reſidence at Dorovernum, ſince called *Canterbury*; to which they were confined till the king himſelf was converted, whoſe example had a powerful influence in promoting the converſion of his ſubjects; but though he was extremely pleaſed at their becoming Chriſtians, he never attempted to compel them. He diſpatched a prieſt and a monk to Rome, to acquaint the pope with the ſucceſs of his miſſion, and to deſire his reſolution of certain queſtions. Theſe men brought back with them a pall, and ſeveral books, veſtments, utenſils, and ornaments for the churches. His holineſs, by the ſame meſſengers, gave Auguſtin directions concerning the ſettling of epiſcopal ſees in Britain; and ordered him not to pull down the idol-temples, but to convert them into Chriſtian churches; only deſtroying the idols, and ſprinkling the place with holy water, that the natives, by frequenting the temples they had been always accuſtomed to, might be the leſs ſhocked at their entrance into Chriſtianity. Auguſtin reſided principally at Canterbury, which thus became the metropolitan church of England; and having eſtabliſhed biſhops in ſeveral of the cities, he died on the 26th of May, 607. The Popiſh writers aſcribe ſeveral miracles to him. The obſervation of the feſtival of St Auguſtin was firſt injoined in a ſynod held under Cuthbert archbiſhop of Canterbury, and afterwards by the pope's bull in the reign of king Edward III. Auguſtine.

AUGUSTINE (St), an illuſtrious father of the church, was born at Thagaſte, a city Numidia, on the 13th of November 354. His father, a burgeſs of that city, was called *Patricius*; and his mother, *Monica*, who being a woman of great virtue, inſtructed him in the principles of the Chriſtian religion. In his early youth he was in the rank of the catechumens; and falling dangerouſly ill, earneſtly deſired to be baptized; but the violence of the diſtemper ceaſing, his baptiſm was delayed. His father, who was not yet baptized, made him ſtudy at Thagaſte, Madaura, and afterwards at Carthage. Auguſtine having read Cicero's books of philoſophy, began to entertain a love for wiſdom, and applied himſelf to the ſtudy of the holy ſcriptures; nevertheleſs, he ſuffered himſelf to be ſeduced by the Manicheans. At the age of 19, he returned to Thagaſte, and taught grammar, and alſo frequented the bar; he afterwards taught rhetoric at Carthage with applauſe. The inſolence of the ſcholars at Carthage made him take a reſolution to go to Rome, tho' againſt his mother's will. Here alſo he had many ſcholars; but diſliking them, he quitted Rome, and ſettled at Milan, and was choſen public profeſſor of rhetoric in that city. Here he had opportunities of hearing the ſermons of St Ambroſe, which, together with the ſtudy of St Paul's epiſtles, and the converſion of two of his friends, determined him to retract his errors, and quit the ſect of the Manicheans; this was in the 32d year of his age. In the vacation of the year 386, he retired to the houſe of a friend of his, named *Verecundus*, where he ſeriouſly applied himſelf to the ſtudy of the Chriſtian religion, in order to prepare himſelf for baptiſm, which he received at Eaſter, in the year 387. Soon after this, his mother came to ſee him at Milan, and invite him back to Carthage; but at Oſtia, whether he went to embark in order to his return, ſhe died. He arrived in Africa about the end of the year 388; and having obtained a garden-plot without the walls of the city of Hippo, he aſſociated himſelf with 11 other perſons of eminent ſanctity, who diſtinguiſhed themſelves by wearing leathern girdles, and lived there in a monaſtic way for the ſpace of three years, exerciſing themſelves in faſting, praying, ſtudy, and meditation, day and night: from hence ſprung up the Auguſtine friars, or eremites of St Auguſtine, being the firſt order of mendicants; thoſe of St Jerome, the Carmelites, and others, being but branches of this of St Auguſtine. About this time, or before, Valerius biſhop of Hippo, againſt his will, ordained him prieſt: nevertheleſs, he continued to reſide in his little monaſtery, with his brethren, who, renouncing all property, poſſeſſed their goods in common. Valerius, who had appointed St Auguſtine to preach in his place, allowed him to do it in his preſence, contrary to the cuſtom of the churches in Africa. He explained the creed, in a general council of Africa, held in 393. Two years after, Valerius, fearing he might be preferred to be biſhop of another church, appointed him his coadjutor or colleague, and cauſed him to be ordained biſhop of Hippo, by Megalus biſhop of Calame, then primate of Numidia. St Auguſtine died the 28th day of Auguſt, 430, aged 76 years, having had the misfortune to ſee his country invaded by the Van-

Auguſtine | Auguſto-dunum.

Vandals, and the city where he was biſhop beſieged for ſeven months.

The works of St Auguſtine make ten volumes; the beſt edition of them is that of Maurin, printed at Antwerp, in 1700. They are but little read at this time, except by the clergy of the Greek church and in the Spaniſh univerſities. The bookſellers of London receive frequent commiſſions for them, and indeed for the moſt of the fathers, from Ruſſia, and alſo from Spain.

AUGUSTINE (St) a fort of North America, on the eaſt coaſt of Cape Florida, ſituated in W. Long. 81. 10. N. Lat. 30. 0. This fort was built by the Spaniards; who were ſcarce well eſtabliſhed there when they were attacked by Sir Francis Drake in 1586, who reduced and pillaged the fort and town adjacent. In 1665, it underwent a ſimilar fate, being attacked by Captain Davis at the head of a conſiderable company of bucaneers. In 1702 an attempt was made by Colonel More to annex St Auguſtine to the Britiſh dominions. He inveſted it with only 500 Engliſh and 700 Indians; which ſmall force, however, would have been ſufficient to reduce the place, had not ſuccours arrived when it was on the point of ſurrendering. Even then, it is thought that he might have defeated the reinforcement which arrived; but he choſe to raiſe the ſiege, and retire with precipitation. In 1740, another unſucceſsful attempt was made on this fort by general Oglethorpe: it was, however, together with the whole country of Florida, ceded to Great Britain by the treaty of Paris in 1763; but has ſince been reſtored to Spain by the treaty of peace 1783.

AUGUSTINE, a cape of South America. W. Long. 35. 4. S. Lat. 8. 30.

AUGUSTINS, or AUGUSTINIANS, an order of religious; thus called from St Auguſtin, whoſe rule they obſerve. The Auguſtins, popularly alſo called Auſtin friers, were originally hermits, whom pope Alexander IV. firſt congregated into one body, under their general Lanfranc, in 1256. Soon after their inſtitution, this order was brought into England, where they had about thirty-two houſes at the time of their ſuppreſſion.

The Auguſtins are clothed in black, and make one of the four orders of mendicants. From theſe aroſe a reform, under the denomination of *bare-foot Auguſtins*, or *Minorites*, or *Friers minor*.

There are alſo canons regular of St Auguſtin, who are clothed in white, excepting their cope, which is black. At Paris they are known under the denomination of *religious of* GENEVIEVE; that abbey being the chief of the order. There are alſo nuns and canoneſſes, who obſerve the rules of St Auguſtin.

AUGUSTINIANS are alſo thoſe divines who maintain, on the authority of St Auguſtin, that GRACE is effectual from its nature, abſolutely and morally, and not relatively and gradually. They are divided into rigid and relaxed.

AUGUSTOBONA, a city of the Tricaſſers in aneient Gaul, from whom it was afterwards called *Tricaſſes*, and *Trecaſſæ*; and ſtill further corrupted to *Thracæ or Treci*; whence the modern name *Troyes*, in Champaigne on the Seyne. See TROYES.

AUGUSTODUNUM, the capital of the Ædui, where there was a famous academy or ſchool for the education of youth; now Auſtun, or *Autun*, in the duchy of Burgundy on the Arroux. See AUTUN.

AUGUSTOMAGUS, an ancient town of Gallia Belgica; now *Senlis*, in the Iſle of France. E. Long. 2. 30. N. Lat. 49. 10.

Auguſto-magus | Aviary.

AUGUSTORITUM (anc. geog.), according to ſome authors the capital of the Pictones, afterwards called *Pictavi*; now *Poictiers*. But by Antonine's Itinerary from Burdigala to Argantomagus (or Argenton, as it is interpreted by many), it can be no other but the capital of the Lemovices, now *Limoges*, ſituate between Veſunna of the Petrocorii, or Perigueux, and Argantomagus. E. Long. 1. 22. Lat. 45. 52.

AUGUSTOW, a ſmall but ſtrong town of Poland, in the duchy and Palatinate of Polakia, ſeated on the river Narieu. E. Long. 24. 2. N. Lat. 53. 25.

AUGUSTUS (Fort), a ſmall fortreſs ſeated on a plain at the head of Lochneſs in Scotland, between the rivers Taarf and Orich; the laſt is a conſiderable ſtream, and has over it a ſtone bridge of three arches. The fort conſiſts of four baſtions; within is the governor's houſe, and barracks for 400 men: it was taken by the rebels in 1746, who immediately deſerted it, after demoliſhing what they could. The name of this fort in Erſe is *Kill chuimin*, or *the burial place of the Cummins*. It lies on the road to the Iſle of Sky, which is about 52 miles off; but on the whole way there is not a place fit for the reception of man or horſe.

AUGUSTUS, the appellation conferred upon Cæſar Octavianus, the firſt Roman emperor. See OCTAVIANUS and ROME.

The obſcure name of *Octavianus*, Mr Gibbon obſerves, he derived from a mean family, in the little town of Aricia. It was ſtained with the blood of the proſcription; and he was deſirous, had it been poſſible, to eraſe all memory of his former life. The illuſtrious ſurname of *Cæſar* he had aſſumed, as the adopted ſon of the dictator; but he had too much good ſenſe either to hope to be confounded or to wiſh to be compared with that extraordinary man. It was propoſed in the ſenate, to dignify their miniſter with a new appellation; and after a very ſerious diſcuſſion, that of *Auguſtus* was choſen among ſeveral others, as being the moſt expreſſive of the character of peace and ſanctity, which he uniformly affected. *Auguſtus* was therefore a perſonal, *Cæſar* a family, diſtinction. The former ſhould naturally have expired with the prince on whom it was beſtowed; and however the latter was diffuſed by adoption and female alliance, Nero was the laſt prince who could alledge any hereditary claim to the honours of the Julian line. But at the time of his death, the practice of a century had inſeparably connected thoſe appellations with the imperial dignity, and they have been preſerved by a long ſucceſſion of emperors, Romans, Greeks, Franks, and Germans, from the fall of the republic to the preſent time. A diſtinction was, however, ſoon introduced. The ſacred title of *Auguſtus* was always reſerved for the monarch; the name of *Cæſar* was more freely communicated to his relations; and from the reign of Hadrian at leaſt, was appropriated to the ſecond perſon in the ſtate, who was conſidered as the preſumptive heir of the empire.

AVIARY, a place ſet apart for feeding and propagating birds. It ſhould be ſo large as to give the birds ſome freedom of flight; and turfed, to avoid the appearance of foulneſs on the floor.

AVICENA,

Avicena.

AVICENA, or AVICENES, the prince of Arabian philoſophers and phyſicians, was born at Aſſena, a village in the neighbourthood of Bokhara. His father was from Balkh in Perſia, and had married at Bokhara. The firſt years of Avicenes were devoted to the ſtudy of the Koran and the Belle Lettres. He ſoon ſhowed what he was likely to become afterwards; and the progreſs he made was ſo rapid, that when he was but ten years old, he was perfectly intelligent in the moſt hidden ſenſes of the Koran.

Abou-Abdoullah, a native of Napoulous in Syria, at that time profeſſed philoſophy at Bokhara with the greateſt reputation. Avicènes ſtudied under him the principles of logic; but ſoon diſguſted with the ſlow manner of the ſchools, he ſet about ſtudying alone, and read all the authors that had written on philoſophy, without any other help than that of their commentators. Mathematics had no fewer charms for him; and after reading the firſt ſix propoſitions of Euclid, he got alone to the laſt, having made himſelf perfect maſter of them, and treaſured up all of them equally in his memory.

Poſſeſſed with an extreme avidity to be acquainted with all ſorts of ſciences, he likewiſe devoted himſelf to the ſtudy of medicine. Perſuaded that this divine art conſiſts as much in practice as in theory, he ſought all opportunities of ſeeing the ſick; and afterwards confeſſed, that he had learned more from experience than from all the books he had read. He was now in his 16th year, and already was celebrated for being the light of his age. He reſolved at this age to reſume his ſtudies of philoſophy, which medicine had made him neglect: and he ſpent a year and a half in this painful labour, without ever ſleeping all this time a whole night together. If he felt himſelf oppreſſed by ſleep, or exhauſted by ſtudy, a glaſs of wine refreſhed his waſted ſpirits, and gave him new vigour for ſtudy; if in ſpite of him his eyes for a few minutes ſhut out the light, it then happened to him to recollect and meditate upon all the things that had occupied his thoughts before ſleep. At the the age of 21, he conceived the bold deſign of incorporating, in one work, all the objects of human knowledge; and carried it into execution in an Encyclopedie of 20 volumes, to which he gave the title of the *Utility of Utilities*.

Several great princes had been taken dangerouſly ill, and Avicènes was the only one that could know their ailments and cure them. His reputation increaſed daily, and all the kings of Aſia deſired to retain him in their families.

Mahmud, the ſon of Sabektekin, the firſt ſultan of the Dynaſty of the Samanides, was then the moſt powerful prince of the eaſt. Imagining that an implicit obedience ſhould be paid by all manner of perſons to the injunctions of his will, he wrote a haughty letter to Mamun ſultan of Kharazm, ordering him to ſend Avicènes to him, who was at his court, with ſeveral other learned men. Philoſophy, the friend of liberty and independence, looks down with ſcorn on the ſhackles of compulſion and reſtraint. Avicènes, accuſtomed to the moſt flattering diſtinctions among the great, could not endure the imperious manner of Mahmud's inviting him to his court, and refuſed to go there. But the ſultan of Kharazm, who dreaded his reſentment, obliged the philoſopher to depart with others whom that prince had demanded to be ſent to him. Avicena.

Avicènes pretended to obey; but inſtead of repairing to Gazna, he took the rout of Giorgian. Mahmud, who had gloried in the thoughts of keeping him at his palace, was greatly irritated at his flight. He diſpatched portraits done in crayons of this philoſopher to all the princes of Aſia, with orders to have him conducted to Gazna, if he appeared in their courts. But Avicènes had fortunately eſcaped the moſt diligent ſearch after him. He arrived in the capital of Giorgian, where under a diſguiſed name he performed many admirable cures.

Cabous then reigned in that country. A nephew, whom he was extremely fond of, being fallen ſick, the moſt able phyſicians were called in, and none of them were able to know his ailment, or give him any eaſe. Avicènes was at laſt conſulted. So ſoon as he had felt the young prince's pulſe, he was confident with himſelf, that his illneſs proceeded from a violent love, which he dared not to declare. Avicènes commanded the perſon who had the care of the different apartments in the palace, to name them all in their reſpective order. A more lively motion in the prince's pulſe, at hearing mentioned one of theſe apartments, betrayed a part of his ſecret. The keeper then had orders to name all the ſlaves that inhabited that apartment. At the name of one of theſe beauties, the young Cabous could not contain himſelf; an extraordinary beating of his pulſe compleated the diſcovery of what he in vain deſired to keep concealed. Avicènes, now fully aſſured that this ſlave was the cauſe of this prince's illneſs, declared, that ſhe alone had the power to cure him.

The Sultan's conſent was neceſſary, and he of courſe was curious to ſee his nephew's phyſician. He had ſcarce looked at him, when he knew in his features thoſe of the crayoned portrait ſent him by Mahmud; but Cabous, far from forcing Avicènes to repair to Gazna, retained him for ſome time with him, and heaped honours and preſents on him.

This philoſopher paſſed afterwards into the court of Nedjmeddevle, Sultan of the race of the Bouides. Being appointed firſt phyſician to that prince, he found means to gain his confidence to ſo great a degree, that he raiſed him to the poſt of Grand Viſir. But he did not long enjoy that illuſtrious dignity. Too great an attachment for pleaſures, eſpecially thoſe of love and the table, made him loſe at the ſame time his poſt and his maſter's favour. From that time Avicènes felt all the rigours of adverſity, which he had brought upon himſelf by his ill conduct. He wandered about as a fugitive, and was often obliged to ſhift the place of his habitation to ſecure his life from danger. He died at Hamadan, aged 58 years, in the 428th year of the Hegira, and of Chriſt 1036.

The perfect knowledge he had of phyſic did not ſecure him from the ailments that afflict human nature. He was attacked by ſeveral maladies in the courſe of his life, and particularly was very ſubject to the colic. His exceſſes in pleaſure, and his infirmities, made a poet ſay, who wrote his epitaph, that the profound ſtudy of philoſophy had not taught him good morals, nor that of medicine the art of preſerving his own health.

Avicens, Avicenia.

No one compoſed with greater facility than Avicènes, writing, when he ſat down to it, 50 pages generally in a day, without fatiguing himſelf. The doctors of Chiras, having made a collection of objections againſt one of his metaphyſical works, ſent it to him at Iſpahan by Caſem. This learned man, not arriving till towards evening, came to Avicènes's houſe, with whom he ſat diſcourſing till midnight. When Caſem was retired, he wrote an anſwer to the objections of the Chirazians, and finiſhed it before ſun-riſe. He immediately delivered it to Caſem, telling him, that he had made all poſſible diſpatch in order not to detain him any longer at Iſpahan.

Avicènes, after his death, enjoyed ſo great a reputation, that till the 12th century he was preferred for the ſtudy of philoſophy and medicine to all his predeceſſors. His works were the only writings in vogue in ſchools, even in Europe. The following are the titles. 1. Of the Utility and Advantage of Sciences, XX books. 2. Of Innocence and Criminality, II books. 3. Of Health and Remedies, XVIII books. 4. On the Means of preſerving Health, III books. 5. Canons of Phyſic, XIV books. 6. On Aſtronomical Obſervations, I book. 7. On Mathematical Sciences. 8. Of Theorems, or Mathematical and Theological Demonſtrations, I book. 9. On the Arabic Language, and its Proprieties, X books. 10. On the Laſt Judgment. 11. On the Origin of the Soul, and the Reſurrection of Bodies. 12. Of the End we ſhould propoſe to ourſelves in Harangues and Philoſophical Argumentation. 13. Demonſtration of the collateral Lines in the Sphere. 14. Abridgment of Euclid. 15. On Finity and Infinity. 16. On Phyſics and Metaphyſics. 17. On Animals and Vegetables, &c. 18. Encyclopedie, 20 volumes.—Some, however, charge him with having ſtolen what he publiſhed, from a celebrated phyſician who had been his maſter. This man had acquired ſo much honour and wealth, that he was ſolicited by many to take their ſons to be his ſcholars, or even his ſervants; but being reſolved not to diſcover the ſecrets of his art, he would receive none of them. Avicènes's mother formed the following ſtratagem: ſhe offered him her ſon as a ſervant, pretending he was naturally deaf and dumb; and the youth, by his mother's inſtructions, counterfeited theſe defects ſo well, that the phyſician, after making ſeveral trials to diſcover the reality of them, took the boy into his ſervice, and by degrees truſted him ſo far as to leave his writings open in his room when he went abroad: Avicènes took that opportunity to tranſcribe them, and carried the copies to his mother; and after the death of his maſter he publiſhed them under his own name. Indeed if we reflect that he lived but 58 years, that he was a wanderer and a fugitive, and that he was much addicted to his pleaſures, we ſhall have ſome difficulty to conceive how he could find time to compoſe ſo many works. Phyſic, however, is indebted to him for the diſcovery of caſſia, rhubarb, mirabolans, tamarinds; and from him alſo, it is ſaid, came to us the art of making ſugar.

AVICENIA, Eastern Anacardium: A genus of the angioſpermia order, belonging to the didynamia claſs of plants; and in the natural method ranking under the 40th order, *Perſonatæ*. The calyx is quinquepartite; the corolla is bilabiated, the upper lip ſquared; the capſule is leathery, romb-like, and monoſpermous. There are two ſpecies; the tomentoſa or downy, and the nitida or ſhining. The ſeeds of the firſt are ſaid to be the Malacca beans formerly kept in the ſhops (though this is doubtful), the kernels of which were eaten as almonds. The plant producing the Malacca bean, as it is called, is rather thought to be the Bontia *Germinans*.

Avigate || Avignon.

AVIGATO pear. See Laurus.

AVIGLIANO, a ſmall town of Piedmont in Italy. E. Long. 7. 5. N. Lat. 44. 40.

AVIGNON, a city of Provence in France, the capital of the county of Venaiſſin, and ſeated on the banks of the Rhone. It is an archbiſhop's ſee, and the reſidence of ſeveral popes at this place for 70 years has rendered it conſiderable. It ſtill belongs and is ſubject to the pope, who ſends a vice-legate every three years, who in ſome ſenſe is the governor: and Mr Swinburn is of opinion the eccleſiaſtical government here is more for the benefit of the people than if they were ſubject to the king of France. Near the Rhone there is a large rock, within the circumference of the walls, upon which is a platform, from whence may be had a proſpect of the whole city and the places about it. This city is about three miles and two furlongs in circumference, and is in general ill built, irregular, and devoid of beauty. But it is ſurrounded by handſome battlemented walls and turrets, not unlike thoſe of Rome; and its public edifices are large, ſolid, and grand as the taſte of the fourteenth century could make them. Several popes and anti-popes, who during their lives ſhook the Romiſh church with violence and mutual altercation, repoſe quietly near each other in the various monaſteries of the place. The church of the Cordeliers contains, in an obſcure corner, the almoſt defaced tomb of Petrarch's Laura and her huſband Hugh de Sade; and nearly oppoſite is the tomb of the brave Gullon, ſo well known for his invincible courage as well as for his inviolable attachment to his ſovereign Henry IV. Many productions of Rerè of Anjou are to be ſeen in the city; whoſe inhabitants amount to above 30,000, of which 1000 are eccleſiaſtics and ſome hundreds of Jews. The palace of the vice-legate is compoſed of ſeveral large ſquare towers, and he gives audience in a great hall which is full of fine paintings, as is alſo the chapel and the apartments. The arſenal is near the palace.

The church of Notre Dame is ancient, but not large, and is one of the beſt adorned in the city. After having aſcended about 50 ſteps, you come to a very ancient portico, which ſuſtains a great tower; as you enter the church on the left hand, you ſee paintings which equal the fineſt in Italy. The great altar is very magnificent, and is adorned with a ſhrine that contains the relics of we know not how many ſaints. The treaſure of the ſacriſty is worthy of the curioſity of the traveller. The little palace where the archbiſhop reſides is formed of three bodies of lodgings, accompanied with courts and ſmall pavilions. It overlooks the Rhone, the city, and the fields. Theſe buildings and the mint adorn a large ſquare, which is the common walk of the inhabitants.

In Avignon they reckon ſeven gates, ſeven palaces, ſeven colleges, ſeven hoſpitals, ſeven monaſteries, ſeven nunneries, and ſeven popes who have lived there

Avignon. in 70 years. The ſteeples are numerous, and the bells are never at reſt; one of ſilver is rung only on the death of a pope. The church of the Celeſtines is very magnificent, and full of fine monuments, and the reſt are not without their curioſities. The univerſity has four colleges; and the place where the Jews, live is a diſtinct quarter, from whence the Jews, who pay tribute, dare not ſtir out without yellow hats, and the women muſt have ſomething yellow about their heads, to diſtinguiſh them from the Chriſtians. Their number is very conſiderable in a very confined place, where the only way of enlarging their abodes is by building their houſes higher. Their ſynagogue is ſo dark, that they are obliged to light lamps. However, they are forced to hear a monk preach a ſermon every week. Acroſs the Rhone, here, extend the ruinous and decayed arches of that bridge againſt which Madame de Grignan was ſo near being loſt, and of which Madame de Sevigné makes terrified mention. It was demoliſhed in 1699 by one of the inundations common to the Rhone. When entire, it was not leſs than a quarter of a mile in length; but being ſo narrow as not to permit two carriages to paſs in any part, it had previouſly become almoſt uſeleſs; and motives of policy prevent the conſtruction of a new bridge, while Avignon belongs to the papal ſee. The curious that travel this way go to ſee the fountain of Vaucluſe, where the river Sorgues, which paſſes through this city, has its ſource; and whither Petrarch ſo often retired to indulge his grief and hopeleſs love. It is ſituated in a valley five miles diſtant from the city. The ſides of the river are ſkirted by meadows of the moſt lively green; above which riſe abrupt and lofty rocks, that ſeem deſigned to ſeclude it from human view. The valley becomes gradually narrower toward the extremity, and winding continually deſcribes the figure of a horſe-ſhoe. The view is at length terminated by an enormous maſs of rock, forming a barrier acroſs it, of a prodigious height, and abſolutely perpendicular. Through its vaſt receſſes run the ſtreams which ſupply the fountain of Vaucluſe, and at its foot appears a baſon of water, ſeveral hundred feet in circumference, ſtretched like an expanſe, ſilent and quiet. The ſides are very ſteep, and it is ſaid that in the middle no bottom can be diſcovered, though attempts have been often made for that purpoſe; a circumſtance probably reſulting from the violence with which the ſprings bubble up, which prevents any weight from deſcending beyond a certain depth. Though the fountain is clearer in itſelf than cryſtal, yet the incumbent rock caſts a continual ſhade, approaching to black, over its ſurface. The water eſcaping from this ſtate of inaction by a narrow paſſage, is immediately precipitated in a caſcade down a rocky channel, where it foams over a number of vaſt detached ſtones, which intercept and impede its progreſs. They are covered with a deep green moſs of many ages, and have probably tumbled from the mountains that overhang the torrent. The rocks themſelves, which ſurround and inveſt this romantic ſpot, are worn by time and the inclemency of the weather into a thouſand extraordinary and fantaſtic forms, to which imagination gives ſhape and figure. On one of the pointed extremities, and in a ſituation which appears almoſt inacceſſible, are ſeen the remains of an ancient caſtle, projecting over the water. The peaſants call it *Il caſtelle di Petrarca*, and add, with great ſimplicity, that Laura lived upon the oppoſite ſide of the river, under the bed of which was a ſubterranean paſſage by which the two lovers viſited each other. Nothing is however more certain than that theſe are the ruins of the chateau belonging to the Lords or Seigneurs of Avignon; and the biſhop of Cavaillon reſided in it during the frequent viſits which he uſed to make to Petrarch.—The poet's dwelling was much lower down, and nearer to the bank of the Sorgues, as evidently appears from his minute deſcription of it, and the relation he gives of his quarrel with the Naiads of the ſtream, who encroached during the winter on his little adjoining territory. No remains of it are now to be diſcerned. Below the bridge there is an iſland where the Sorgues joins the Rhone, in which are ſeveral houſes of pleaſure. E. Long. 4. 59. N. Lat. 43. 57. Avignon | Aviſon.

Avignon-Berry, the fruit of a ſpecies of lycium; growing plentifully near Avignon and in other parts of France. The berry is ſomewhat leſs than a pea; its colour is green, approaching towards a yellow; and is of an aſtringent and bitter taſte.—It is much uſed by the dyers, who ſtain a yellow colour with it, and by the painters, who alſo make a fine golden yellow of it.

AVILA, a city of Old Caſtile, in Spain, ſeated on an eminence on the banks of the river Adaja, and in ſight of the mountains of Pico. It is fortified both by nature and art, having a wall 9075 feet in circumference, adorned with 26 lofty towers, and 10 handſome gates. There are 17 principal ſtreets, the houſes in which are generally good, and ſome of them ſtately. It hath nine ſquares, 2000 houſes, nine pariſhes, as many monaſteries, ſeven nunneries, two colleges, nine hoſpitals, 18 chapels, and an allowance of 10,000 ducats yearly for the maintenance of orphans and other poor people. It has an univerſity, and a conſiderable biſhopric; beſides a noble cathedral, which has eight dignitaries, 20 canons, and the ſame number of minor canons. It ſtands in the middle of a fine large plain, ſurrounded with mountains, and covered with fruit-trees and vineyards. There is likewiſe a manufacture of cloth. W. Long. 4. 13. N. Lat. 40. 35.

AVIS, a ſmall town of Alentejo in Portugal, ſeated on an eminence, with a caſtle, near the river Avis. Hence the military order of the knights of Avis have their name. W. Long. 7. 0. N. Lat. 38 40.

Avis *(Knights d'Avis)*, an order of knighthood in Portugal eſtabliſhed about the year 1162. When the city of Evora was taken from the Moors, in the reign of the firſt king of Portugal, it was garriſoned by ſeveral perſons who aſſumed the title of knights of St Mary of Evora, which was ſoon after changed for that of knights d'Avis, which the king gave them, and whither they removed from Evora. The badge of the order is a green croſs flory, and they obſerve the rule of St Benedict.

AVISO, a term chiefly uſed in matters of commerce to denote an advertiſement, an advice, or piece of intelligence.

AVISON (Charles), organiſt of Newcaſtle, and a diſciple of Geminiani, was the author of an eſſay on muſical expreſſion, publiſhed in the year 1752, in which are ſome judicious reflections on muſic in general, but his diviſion of the modern authors into claſſes is rather

Auk ‖ Aulic.

fanciful than juſt. Throughout his book he celebrates Marcello and Geminiani; the latter frequently in prejudice to Mr. Handel. In the year 1753 came out remarks on Mr. Aviſon's eſſay on muſical expreſſion, the author whereof firſt points out ſundry errors againſt the rules of compoſition in the works of Aviſon. In the ſame year Aviſon republiſhed his eſſay, with a reply to the author of the remarks; and a letter, containing a number of looſe particulars relating to muſic collected in a courſe of various reading, unqueſtionably written by Dr Jortin. Aviſon promoted and aſſiſted in the publication of Marcello's muſic to the pſalms adapted to Engliſh words. Of his own compoſition there are extant five collections of concertos for violins, 44 in number; and two ſets of ſonatas for the harpſichord and two violins, a ſpecies of compoſition little known in England till his time. The muſic of Aviſon is light and elegant, but it wants originality; a neceſſary conſequence of his too cloſe attachment to the ſtyle of Geminiani, which in a few particulars only he was able to imitate.

AUK, in ornithology. See ALCA.

BISHOP'S AUKLAND, a town in the biſhopric of Durham in England, ſituated on the river Were. It is a ſanctuary for debtors; and here the biſhop has a princely palace and a noble park. W. Long. 0. 57. N. Lat. 54. 44.

AULA, is uſed for a court baron, by Spelman; by ſome old eccleſiaſtical writers, for the nave of a church, and ſometimes for a court-yard.

AULA Regia or *Regis*, a court eſtabliſhed by William the Conqueror in his own hall, compoſed of the king's great officers of ſtate, who reſided in his palace, and were uſually attendant on his perſon. This court was regulated by the article which forms the eleventh chapter of Magna Charta, and eſtabliſhed in Weſtminſter-hall, where it hath ever ſince continued. See *King's Bench*.

AULCESTER, a town of Warwickſhire in England. W. Long. 1. 47. N. Lat. 52. 15.

AULETES, in antiquity, denotes a flute-player. One of the Ptolemies, kings of Egypt, father of Cleopatra, bore the ſurname or denomination of *Auletes*.

AULIC, an epithet given to certain officers of the empire, who compoſe a court which decides, without appeal, in all proceſſes entered in it. Thus we ſay, *aulic council*, *aulic chamber*, *aulic counſellor*.

The aulic council is compoſed of a preſident, who is a catholic; of a vice-chancellor, preſented by the archbiſhop of Mentz; and of 18 counſellors, nine of whom are proteſtants and nine catholics. They are divided into a bench of lawyers, and always follow the emperor's court; for which reaſon they are called *juſtitium imperatoris*, the emperor's juſtice, and aulic council. The aulic court ceaſes at the death of the emperor; whereas the imperial chamber of Spire is perpetual, repreſenting not only the deceaſed emperor, but the whole Germanic body, which is reputed never to die.

AULIC, in the Sorbonne and foreign univerſities, is an act which a young divine maintains upon being admitted a doctor in divinity. It begins by an harangue of the chancellor, addreſſed to the young doctor, after which he receives the cap, and preſides at the aulic, or diſputation.

AULIS (anc. geog.), a town of Bœotia, over againſt Chalcis of Eubœa, on the Euripus, where that ſtrait is narroweſt; and which were ſometimes joined together by a mole or cauſeway, (Diodorus Siculus): a craggy ſituation, (Homer, Nonnus); and a village of the Tanagraei, (Strabo), diſtant from Chalcis three miles: A harbour famous for the rendezvous of a thouſand ſhips under Agamemnon, previous to the Trojan expedition, (Livy, Virgil, Pliny). Now entirely deſtroyed.

Aulis ‖ Aungervyle.

AULNEGER. See ALNAGER.

AULON, anciently a town and dock or ſtation for ſhips in Illyricum, on the Adriatic; now *Valona*, or *Volana*, a port-town in the duchy of Ferara on one of the mouths of the Po, on the gulf of Venice. E. Long. 13. Lat. 44. 50.

AULON, or *Aulona*, anciently a town of Elis, in Peloponneſus, on the confines of Meſſenia. Here ſtood a temple of Æſculapius; hence the epithet *Aulonius* given that divinity, (Pauſanias).

AULOS, a Grecian long meaſure, the ſame with ſtadium.

AULPS, a town of Provence in France, in the dioceſe of Trejus, with the title of a Vigueria. E. Long. 6. 25. N. Lat. 43. 40.

AULUS GELLIUS. See GELLIUS.

AUMBRY, a country-word denoting a cup-board.

AUME, a Dutch meaſure for Rheniſh wine, containing 40 Engliſh gallons.

AUNCEL-WEIGHT, an ancient kind of balance now out of uſe, being prohibited by ſeveral ſtatutes, on account of the many deceits practiſed by it. It conſiſted of ſcales hanging on hooks, faſtened at each end of a beam, which a man lifted up on his hand. In many parts of England, auncel-weight ſignifies meat ſold by the hand, without ſcales.

AUNE, a long meaſure uſed in France to meaſure cloths, ſtuffs, ribbons, &c. At Rouen, it is equal to one Engliſh ell; at Calais, to 1.52; at Lyons, to 1.061; and at Paris, to 0.95

AUNGERVYLE (Richard), commonly known by the name of *Richard de Bury*, was born in 1281 at St Edmund's Bury in Suffolk, and educated at the univerſity of Oxford: After which he entered into the order of Benedictine monks, and became tutor to Edward prince of Wales, afterwards king Edward III. Upon the acceſſion of his royal pupil to the throne he was firſt appointed cofferer, then treaſurer of the wardrobe, archdeacon of Northampton, prebendary of Lincoln, Sarum, and Litchfield, keeper of the privy ſeal, dean of Wells, and laſt of all was promoted to the biſhoprick of Durham. He likewiſe enjoyed the offices of lord high chancellor, and treaſurer of England; and diſcharged two important embaſſies at the court of France. Learned himſelf, and a patron of the learned, he maintained a correſpondence with ſome of the greateſt geniuſes of the age, particularly with the celebrated Italian poet Petrarch. He was alſo of a moſt humane and benevolent temper, and performed many ſignal acts of charity. Every week he made eight quarters of wheat into bread, and gave it to the poor. Whenever he travelled between Durham and Newcaſtle, he diſtributed eight pounds ſterling in alms; between Durham and Stockton five pounds, between Durham and Aukland five marks, and between Durham and

Middleham

Aunis | Aura.

Middleham five pounds. He founded a public library at Oxford, for the uſe of the ſtudents, which he furniſhed with the beſt collection of books then in England; and appointed five keepers, to whom he granted yearly ſalaries. At the diſſolution of religious houſes in the reign of Henry VIII. Durham college, where he fixed the library, being diſſolved among the reſt, ſome of the books were removed to the public library, ſome to Baliol college, and ſome came into the hands of Dr George Owen, a phyſician of Godſtow, who bought that college of king Edward VI. Biſhop Aungervyle died at his manor of Aukland, April 24, 1345, and was buried in the ſouth part of the croſs iſle of the cathedral church of Durham, to which he had been a benefactor. He wrote, 1. *Philobiblos*, containing directions for the management of his library at Oxford, and a great deal in praiſe of learning, in bad Latin. 2. *Epiſtolæ familiarium*; ſome of which are written to the famous Petrarch. 3. *Orationes ad principes*; mentioned by Bale and Pitts.

AUNIS, the ſmalleſt province in France, bounded on the north by Poictou, on the weſt by the ocean, on the eaſt and ſouth by Saintogne, of which it was formerly a part It is watered by the rivers Seure and Sarente, the former of which has its ſource at Seure in Poictou. The coaſt of this ſmall diſtrict has the advantage of ſeveral ports, the moſt remarkable of which are Rochefort, Rochelle, Brouge, St Martin de Re, Tremblade, Tonnai, and Charente. The ſoil of this country is dry, yet produces good corn and plenty of wine. The marſhes feed a great number of cattle, and the ſalt marſhes yield the beſt ſalt in Europe.

AVOCADO, or AVIGATO, *Pear*. See LAURUS.

AVOCATORIA, a mandate of the emperor of Germany, addreſſed to ſome prince, in order to ſtop his unlawful proceedings in any cauſe appealed to him.

AVOIDANCE, in the canon law, is when a benefice becomes void of an incumbent; which happens either in fact, as by the death of the perſon; or in law, as by ceſſion, deprivation, reſignation, &c. In the firſt of theſe caſes, the patron muſt take notice of the avoidance at his peril; but in avoidance by law, the ordinary is obliged to give notice to the patron, in order to prevent a lapſe.

AVOIRDUPOIS. This is the weight for the larger and coarſer commodities, ſuch as groceries, cheeſe, wool, lead, &c. Bakers, who live not in corporation towns, are to make their bread by avoirdupois weight, thoſe in corporations by troy weight. Apothecaries buy by avoirdupois weight, but ſell by troy. The proportion of a pound avoirdupois to a pound troy is as 17 to 14.

AVOSETTA, in ornithology. See RECURVIROSTRA.

AVOWEE, one who has a right to preſent to a benefice. He is thus called in contradiſtinction to thoſe who only have the lands to which the advowſon belongs for a term of years, or by virtue of intruſion or diſſeiſin.

AVOWRY, in law, is where a perſon diſtrained ſues out a replevin; for then the diſtrainer muſt vow, and juſtify his plea, which is called his *avowry*.

AURA, among phyſiologiſts, an airy exhalation or vapour. The word is Latin, derived from the Greek, αυρα, *gentle wind*.

Aurach | Aurelius.

AURACH, a town of Germany with a good caſtle, in the ſouth part of Suabia, in the duchy of Wirtemberg. It is the uſual reſidence of the youngeſt ſons of the houſe of Wirtemberg, and is ſeated at the foot of a mountain on the rivulet Ermſt. E. Long. 9. 20. N. Lat. 48. 25.

AURÆ, in mythology, a name given by the Romans to the nymphs of the air. They are moſtly to be found in the ancient paintings of ceilings; where they are repreſented as light and airy, generally with long robes and flying veils of ſome lively colour or other, and fluttering about in the rare and pleaſing element aſſigned to them. They are characteriſed as ſportive and happy in themſelves, and well-wiſhers to mankind.

AURANCHES, the capital of a territory called *Auranchin*, about 30 miles in length, in Lower Normandy in France. The city is mean; but its ſituation very fine, being on an eminence, near which the river See runs, about a mile and a half from the ocean. The cathedral ſtands on a hill, which terminates abruptly; the front of the church extending to the extreme verge of it, and overhanging the precipice. It bears the marks of high antiquity; but the towers are decayed in many places, though its original conſtruction has been wonderfully ſtrong. Here, you are told, the Engliſh Henry II. received abſolution from the Papal nuncio for the murder of St Thomas-a-Becket in 1172; and the ſtone on which he knelt during the performance of that ceremony is ſhown to ſtrangers. Its length is about 30 inches, and the breadth 12. It ſtands before the north portal, and on it is engraved a chalice in commemoration of the event.—The ruins of the caſtle of Auranches are very extenſive, and beneath lies a rich extent of country, abounding in grain and covered with orchards, from the fruit of which is made the beſt cyder in Normandy. W. Long. 1. 20. N. Lat. 48. 51.

AURANTIUM, in botany. See CITRUS.

AURAY, a ſmall ſeaport town of Lower Brittany in France, ſituated in the gulph called *Morbian*. It is nothing, properly ſpeaking, but a large quay, and a handſome ſtreet, being chiefly known for its trade. W. Long. 2. 25. N. Lat. 47. 48.

AURELIA, in natural hiſtory, the ſame with what is more uſually called *chryſalis*, and ſometimes *nymph*. See CHRYSALIS.

AURELIANUS (Lucius Domitius), emperor of Rome, was one of the greateſt generals of antiquity, and commanded the armies of the emperor Claudius with ſuch glory, that after the death of that emperor all the legions agreed to place him on the throne: this happened in the year 270. He carried the war from the eaſt to the weſt, with as much facility, ſays a modern writer, as a body of troops marches from Alſace into Flanders. He defeated the Goths, Sarmatians, Marcomanni, the Perſians, Egyptians, and Vandals; conquered Zenobia queen of the Palmyrenians, and Tetricus general of the Gauls; both of whom were made to grace his triumph, in the year 274. He was killed by one of his generals in Thrace in the year 275, when he was preparing to enter Perſia with a great army. See ROME.

AURELIUS VICTOR. See VICTOR.

Aurengabad | Aurillac.

AURENGABAD, a city in the East Indies, capital of the province of Balagate, in the dominions of the Great Mogul. It is furnished with handsome mosques and caravanseras. The buildings are chiefly of freestone, and pretty high, and the streets planted on each side with trees. They have large gardens well stocked with fruit-trees and vines. The soil about it is also very fertile, and the sheep fed in its neighbourhood are remarkably large and strong. E. Long. 75. 30. N. Lat. 19. 10.

AURENG-ZEBE, the Great Mogul. See INDOSTAN.

AUREOLA, in its original signification, signifies a jewel, which is proposed as a reward of victory in some public dispute. Hence the Roman schoolmen applied it to denote the reward bestowed on martyrs, virgins, and doctors, on account of their works of supererogation; and painters use it to signify the crown of glory with which they adorn the heads of saints, confessors, &c.

AUREUS, a Roman gold coin, equal in value to 25 denarii.—According to Ainsworth, the aureus of the higher empire weighed near five pennyweights; and in the lower empire, little more than half that weight, We learn from Suetonius, that it was customary to give aurei to the victors in the chariot-races.

AUREUS MONS (anc. geog.), a mountain in the north-west of Corsica, whose ridge runs out to the north-east and south-east, forming an elbow—Another mountain of Moesia Superior, or Servia (Peutinger), to the south of the Danube, with a cognominal town at its foot on the same river. The emperor Probus planted this mountain with vines (Eutropius).

AURICK, a city of Germany; in East Friesland, in the circle of Westphalia; to which the king of Prussia claims a right. It is situated in a plain surrounded with forests full of game. E. Long. 6. 50. N. Lat. 53. 28.

AURICLE, in anatomy, that part of the ear which is prominent from the head, called by many authors *auris externa*.

AURICLES are likewise two muscular bags situated at the basis of the heart, and intended as diverticula for the blood during the diastole.

AURICULA, in botany. See PRIMULA.

AURIFLAMMA, in the French history, properly denotes a flag or standard belonging to the abbey of St Dennis, suspended over the tomb of that saint, which the religious, on occasion of any war in defence of their lands or rights, took down, with great ceremony, and gave it to their protector or advocate, to be borne at the head of their forces.

AURIFLAMMA is also sometimes used to denote the chief flag or standard in any army.

AURIGA, *the* WAGGONER, in astronomy, a constellation of the northern hemisphere, consisting of 23 stars, according to Tycho; 40, according to Hevelius; and 68, in the Britannic catalogue.

AURILLAC, a town of France in the Lower Auvergne, seated on a small river call *Jordane*. It is one of the most considerable towns of the province, has six gates, is very populous, and yet has but one parish. The castle is very high, and commands the town. The abbot is lord of Aurillac, and has episcopal jurisdiction; he is also chief justice of the town. This place is remarkable for having produced several great men. E. Long. 2. 33. N. Lat. 44. 55.

Auripigmentum | Aurora Borealis.

AURIPIGMENTUM, ORPIMENT, in natural history. See ORPIMENT.

AURISCALPIUM, an instrument to clean the ears, and serving also for other operations in disorders of that part.

AURORA, the morning twilight, or that faint light which appears in the morning when the sun is within 18 degrees of the horizon.

AURORA, the goddess of the morning, according to the Pagan mythology. She was the daughter of Hyperion and Theia, according to Hesiod; but of Titan and Terra, according to others. It was under this name that the ancients deified the light which foreruns the rising of the sun above our hemisphere. The poets represent her as rising out of the ocean, in a chariot, with rosy fingers dropping gentle dew. Virgil describes her ascending in a flame-coloured chariot with four horses.

AURORA, one of the New Hebrides islands in the South Sea, in which Mr Forster supposes the *Peak d'Etoile* mentioned by Mr Bouganville to be situated. The island is inhabited; but none of its inhabitants came off to visit Captain Cook. The country is woody, and the vegetation seemed to be excessively luxuriant. It is about 12 leagues long, but not above five miles broad in any part; lying nearly north and south. The middle lies in S. Lat. 15. 6. E. Long. 168. 24.

AURORA BOREALIS, NORTHERN TWILIGHT, or *Streamers*; a kind of meteor appearing in the northern part of the heavens, mostly in the winter-time, and in frosty weather. It is now so generally known, that no description is requisite of the appearance which it usually makes in this country. But it is in the arctic regions that it appears in perfection, particularly during the solstice. In the Schetland islands, the *merry dancers*, as they are there called, are the constant attendants of clear evenings, and prove great reliefs amidst the gloom of the long winter-nights. They commonly appear at twilight near the horizon, of a dun colour, approaching to yellow; sometimes continuing in that state for several hours without any sensible motion; after which they break out into streams of stronger light spreading into columns, and altering slowly into ten thousand different shapes, varying their colours from all the tints of yellow to the obscurest russet. They often cover the whole hemisphere, and then make the most brilliant appearance. Their motions at these times are most amazingly quick; and they astonish the spectator with the rapid change of their form. They break out in places where none were seen before, skimming briskly along the heavens; are suddenly extinguished, and leave behind an uniform dusky tract. This again is brilliantly illuminated in the same manner, and as suddenly left a dull blank. In certain nights they assume the appearance of vast columns, on one side of the deepest yellow, on the other declining away till it becomes undistinguished from the sky. They have generally a strong tremulous motion from end to end, which continues till the whole vanishes. In a word, we, who only see the extremities of these northern phenomena, have but a faint idea

Aurora Borealis.

ideas of their ſplendor and their motions. According to the ſtate of the atmoſphere, they differ in colours. They often put on the colour of blood, and make a moſt dreadful appearance. The ruſtic ſages become prophetic, and terrify the gazing ſpectators with the dread of war, peſtilence, and famine. This ſuperſtition was not peculiar to the northern iſlands; nor are theſe appearances of recent date. The ancients called them *Chaſmata*, and *Trabes*, and *Bolides*, according to their forms or colours.

In old times they were extremely rare, and on that account were the more taken notice of. From the days of Plutarch to thoſe of our ſage hiſtorian Sir Richard Baker, they were ſuppoſed to have been portentous of great events, and timid imaginations ſhaped them into aerial conflicts:

Fierce fiery warriors fight upon the clouds
In ranks and ſquadrons and right form of war.

1 This meteor formerly very rare.

Dr Halley tells us, that when he ſaw a great aurora borealis in 1716, he had begun to deſpair of ever ſeeing one at all; none having appeared, at leaſt in any conſiderable degree, from the time he was born till then. Notwithſtanding this long interval, however, it ſeems that in ſome periods the aurora borealis had been ſeen much more frequently; and perhaps this, as well as other natural phenomena, may have ſome ſtated times of returning.

2 Hiſtory by Dr Halley.

The only thing that reſembles a diſtinct hiſtory of this phenomenon, is what we have from the learned Dr Halley, Phil. Tranſ. n° 347. The firſt account he gives, is of the appearance of what is called by the author *burning ſpears*, and was ſeen at London on January 30th, 1560. This account is taken from a book intitled, *A deſcription of Meteors*, by *W. F.* D. D. and reprinted at London in 1654. The next appearance, on the teſtimony of Stow, was on October 7th, 1564. In 1574 alſo, according to Camden, and Stow abovementioned, an aurora borealis was obſerved two nights ſucceſſively, *viz.* on the 14th and 15th of November, with much the ſame appearance as deſciribed by Dr Halley in 1715-16, and which we now ſo frequently obſerve. Again, the ſame was twice ſeen in Brabant, in the year 1575; *viz.* on the 13th of February and 28th of September. Its appearances at both theſe times were deſcribed by Cornelius Gemma, profeſſor of medicine in the univerſity of Lovain, who compares them to ſpears, fortified cities, and armies fighting in the air. After this, Michael Mæſtlin, tutor to the great Kepler, aſſures us, that at Baknang in the county of Wurtemberg in Germany, theſe phenomena, which he ſtyles *chaſmata*, were ſeen by himſelf no leſs than ſeven times in 1580. In 1581, they again appeared in an extraordinary manner in April and September, and in a leſs degree at ſome other times of the ſame year. In 1621, September 2d, this phenomenon was obſerved all over France, and deſcribed by Gaſſendus, who gave it the name of *aurora borealis*: yet neither this, nor any ſimilar appearances poſterior to 1574, are deſcribed by Engliſh writers till the year 1707; which, as Dr Halley obſerves, ſhows the prodigious neglect of curious matters which at that time prevailed. From 1621 to 1707, indeed, there is no mention made of an aurora borealis being ſeen by any body: and conſidering the number of aſtronomers who during that period were in a manner continually poring on the heavens, we may very reaſonably conclude that no ſuch thing did make its appearance till after an interval of 86 years. In 1707, a ſmall one was ſeen in November; and during that year and the next, the ſame appearances were repeated five times. The next, on record is that mentioned by Dr Halley in March 1715-16, the brilliancy of which attracted univerſal attention, and by the vulgar was conſidered as marking the introduction of a foreign race of princes. Since that time thoſe meteors have been ſo common, that no accounts have been kept of them.

Aurora Borealis.

It was for a long time a matter of doubt whether this meteor made its appearance only in the northern hemiſphere, or whether it was alſo to be obſerved near the ſouth pole. This is now aſcertained by Mr Forſter; who in his late voyage round the world along with Captain Cook, aſſures us, that he obſerved them in the high ſouthern latitudes, though with phenomena ſomewhat different from thoſe which are ſeen here. On Feb. 17, 1773, as they were in Lat. 58° ſouth, "A beautiful phenomenon (ſays he) was obſerved during the preceding night, which appeared again this and ſeveral following nights. It conſiſted of long columns of a clear white light, ſhooting up from the horizon to the eaſtward, almoſt to the zenith, and gradually ſpreading on the whole ſouthern part of the ſky. Theſe columns were ſometimes bent ſideways at their upper extremities; and though in moſt reſpects ſimilar to the northern lights *(aurora borealis)* of our hemiſphere, yet differed from them in being always of a whitiſh colour, whereas ours aſſume various tints, eſpecially thoſe of a fiery and purple hue. The ſky was generally clear when they appeared, and the air ſharp and cold, the thermometer ſtanding at the freezing-point."

3 Mr Forſter's account of ſimilar appearances in the ſouthern hemiſphere.

Dr Halley obſerved that the aurora borealis deſcribed by him aroſe to a prodigious height, it being ſeen from the weſt of Ireland to the confines of Ruſſia and Poland on the eaſt; nor did he know how much farther it might have been viſible; ſo that it extended at leaſt 30 degrees in longitude, and from lat. 50° north it was ſeen all over the northern part of Europe; and what was very ſurpriſing, in all thoſe places where it was viſible, the ſame appearances were exhibited which Dr Halley obſerved at London. He obſerves, with ſeeming regret, that he could by no means determine its height for want of obſervations made at different places; otherwiſe he might as eaſily have calculated the height of this aurora borealis, as he did of the fiery globe in 1719*. To other philoſophers, however, he gives the following exhortation. "When therefore for the future any ſuch thing ſhall happen, all thoſe that are curious in aſtronomical matters are hereby *admoniſhed* and *intreated* to ſet their clocks to the apparent time at London, for example, by allowing ſo many minutes as is the difference of meridians; and then to note, at the end of every half hour preciſely, the exact ſituation of what at that time appears remarkable in the ſky; and particularly the azimuths of thoſe very tall pyramids ſo eminent above the reſt, and therefore likely to be ſeen furtheſt: to the intent that, by comparing theſe obſervations taken at the ſame moment in diſtant places, the difference of their azimuths may ſerve to determine how far theſe pyramids are diſtant from us." This advice of Dr Halley ſeems to have been totally neglected by all the philoſophical people in Britain. In other countries, however, they have

4 Riſes very high.

*See *Atmoſphere.*

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have been more induſtrious. Father Boſcovich has determined the height of an aurora borealis, obſerved on the 16th of December 1737 by the Marquis of Poleni, to have been 825 miles high; the celebrated Mr Bergman, from a mean of 30 computations, makes the average height of the aurora borealis to be 70 Swediſh, or upwards of 460 Engliſh miles. Euler ſuppoſes it to be ſeveral thouſands of miles high; and Mairan alſo aſſigns them a very elevated region. In the 74th volume of the philoſophical tranſactions, Dr Blagden, when ſpeaking of the height of ſome fiery meteors, tells us, that the "aurora borealis appears to occupy as high, if not a higher region above the ſurface of the earth, as may be judged from the very diſtant countries to which it has been viſible at the ſame time." The height of theſe meteors, however, none of which appear to have exceeded or even arrived at the height of a hundred miles, muſt appear trifling in compariſon of the vaſt elevations abovementioned. But theſe enormous heights, varying ſo exceedingly, ſhow that the calculators have not had proper data to proceed upon; and indeed the immenſe extent of ſpace occupied by the aurora borealis itſelf, with its conſtant motion, muſt make it infinitely more difficult to determine the height of it than of a fiery globe, which occupies but a ſmall portion of the viſible heavens. The moſt certain method of making a compariſon betwixt the aurora borealis and the meteors already mentioned, would be, if a ball of fire ſhould happen to paſs through the ſame part of the heavens where an aurora borealis was; when the comparative height of both could eaſily be aſcertained. One inſtance of this only has come under our obſervation, where one of the ſmall meteors, called *falling ſtars*, was evidently obſcured by an aurora borealis; and therefore muſt have been higher than the lower part of the latter at leaſt. A ſingularity in this meteor was, that it did not proceed in a ſtraight line through the heavens, as is uſual with falling ſtars, but deſcribed a very conſiderable arch of a circle, riſing in the northweſt, and proceeding ſouthward a conſiderable way in the arch of a circle, and diſappearing in the north. Its edges were ill defined, and five or ſix corruſcations ſeemed to iſſue from it like the rays painted as iſſuing from ſtars. The aurora borealis was not in motion, but had degenerated into a crepuſculum in the northern part of the hemiſphere. Indeed in ſome caſes this kind of crepuſculum appears ſo plainly to be connected with the clouds, that we can ſcarcely avoid ſuppoſing it to proceed from them. We cannot, however, argue from this to the height of the aurora borealis when it moves with great velocity, becauſe it then may, and very probably does, aſcend much higher. Dr Blagden, indeed, informs us, that inſtances are recorded, where the northern lights have been ſeen to join, and form luminous balls, darting about with great velocity, and even leaving a train like the common fire-balls. It would ſeem therefore, that the higheſt regions of the aurora borealis are the ſame with thoſe in which fireballs move.

3 Conjectures concerning the cauſe of this meteor.

With regard to the cauſe of the aurora borealis, many conjectures have been formed. The firſt which naturally occurred was, that it was occaſioned by the aſcent of inflammable ſulphureous vapours from the earth. To this ſuppoſition Dr Halley objects the immenſe extent of ſuch phenomena, and that they are conſtantly obſerved to proceed from north to ſouth, but never from ſouth to north. This made him very reaſonably conclude, that there was ſome connection between the poles of the earth and the aurora borealis; but being unacquainted with the electric power, he ſuppoſed, that this earth was hollow, having within it a magnetical ſphere, which correſponded in virtue with all the natural and artificial magnets on the ſurface; and the magnetic effluvia paſſing through the earth, from one pole of the central magnet to another, might ſometimes become viſible, in their courſe, which he thought was from north to ſouth, and thus exhibit the beautiful corruſcations of the aurora borealis. Had Dr Halley, however, known that a ſtroke of electricity would give polarity to a needle that had it not, or reverſe the poles of one that had it before, he would undoubtedly have concluded the electric and magnetic effluvia to be the ſame, and that the aurora borealis was this fluid performing its circulation from one pole of the earth to the other. In fact, this very hypotheſis is adapted by S. Beccaria; and by the ſuppoſed circulation of the electric fluid he accounts for the phenomena of magnetiſm and the aurora borealis in a manner perfectly ſimilar to that of Dr Halley, only changing the phraſe *magnetic effluvia* for *electric fluid*. The following is the account given us by Dr Prieſtley of Beccaria's ſentiments on this matter.

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"Since a ſudden ſtroke of lightning gives polarity to magnets, he conjectures, that a regular and conſtant circulation of the whole maſs of the fluid from north to ſouth may be the original cauſe of magnetiſm in general.

"That this etherial current is inſenſible to us is no proof of its non-exiſtence, ſince we ourſelves are involved in it. He had ſeen birds fly ſo near a thundercloud, as he was ſure they would not have done had they been affected by its atmoſphere.

"This current he would not ſuppoſe to ariſe from one ſource, but from ſeveral, in the northern hemiſphere of the earth; and he thinks that the aurora borealis may be in this electric matter performing its circulation in ſuch a ſtate of the atmoſphere as renders it viſible, or approaching the earth nearer than uſual. Accordingly very vivid appearances of this kind have been obſerved to occaſion a fluctuation in the magnetic needle.

A direct diſproof of this circulation, however, is furniſhed by the obſervation of Mr Forſter already mentioned; with which, though neither Dr Halley nor S. Beccaria could be acquainted, they might have thought of it as a final proof either of the truth or falſehood of their hypotheſis.—If the aurora borealis is no other than the electric fluid performing the abovementioned circulation, it ought to dart from the horizon towards the zenith in the northern hemiſphere, and from the zenith to the horizon in the ſouthern one: but Mr Forſter plainly tells us, that the columns ſhot up from the horizon towards the zenith as well in the ſouthern hemiſphere as in the northern; ſo that if the aurora borealis is to be reckoned the flaſhings of electric matter, its courſe is plainly directed from both poles towards the equator, and not from one pole to the other.

Concerning the cauſe of this phenomenon, Mr Canton has the following query: "Is not the aurora borealis

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realis the flaſhing of electrical fire from poſitive towards negative clouds at a great diſtance, through the upper part of the atmoſphere where the reſiſtance is leaſt?" But to this we muſt reply in the negative; for in this caſe it would flaſh in evey direction according to the poſition of the clouds, as well as from north to ſouth. Beſides this query, he conjectures, that when the needle is diſturbed by the aurora borealis, that phenomenon proceeds from the electricity of the heated air; and ſuppoſes the air to have the property of becoming electric by heat, like the tourmalin. But neither does this hypotheſis appear at all probable; becauſe, in ſuch a caſe, the aurora borealis ought to be moſt frequent in ſummer when the air is moſt heated, whereas it is found to be the reverſe.——Laſtly, with theſe electrical hypotheſes we ſhall contraſt that of Mr Mairan, who imagined this phenomenon to proceed from the atmoſphere of the ſun, particles of which were thrown off by its centrifugal force acquired by his rotation on his axis; and that theſe particles falling upon the atmoſphere of the earth near its equatorial parts, were from thence propelled by the diurnal motion of the earth towards the polar regions, where they formed the aurora borealis. This hypotheſis, beſides its being a mere ſuppoſition unſupported by one ſingle appearance in nature, is liable to the objection already mentioned; for in this caſe the light ſhould dart from the equator to the poles, and not from the poles to the equator: or if we ſhould ſuppoſe this matter to be gradually accumulated at each of the poles, we muſt then make other ſuppoſitions equally vague and ill founded, concerning its getting back with ſuch ſurpriſing rapidity in direct oppoſition to the power which once brought it thither.

The firſt perſon that ſeems to have endeavoured to find any poſitive proof for the electrical quality of the aurora borealis, is Dr Hamilton of Dublin. He obſerves, that though this phenomenon is commonly ſuppoſed to be electrical, yet he had not ſeen any attempt to prove that it is ſo: but the only proof he himſelf brings is an experiment of Mr Hawkſbee, by which the electric fluid is ſhown to put on appearances ſomewhat like the aurora borealis, when it paſſes through a vacuum. He obſerved, that when the air was moſt perfectly exhauſted, the ſtreams of electric matter were then quite white; but when a ſmall quantity of air was let in, the light aſſumed more of a purple colour. The flaſhing of this light therefore from the denſe regions of the atmoſphere into ſuch as are more rare, and the tranſitions through mediums of different denſity, he reckons the cauſe of the aurora borealis, and of the different colours it aſſumes.

Dr Hamilton's proof, then, of the electricity of the aurora borealis, conſiſts entirely in the reſemblance the two lights bear to one another; and if to this we add, that, during the time of an aurora borealis, the magnetic needle hath been diſturbed, electric fire obtained from the atmoſphere in plenty, and at ſome times different kinds of rumbling and hiſſing ſounds heard, we have the ſum of all the poſitive evidence in favour of the electric hypotheſis.

Was the aurora borealis the firſt natural phenomenon the ſolution of which had been attempted by electricity, no doubt the proofs juſt now adduced would be very inſufficient: but when it is conſidered, that we have indiſputable evidence of the identity of the phenomena of thunder and of electricity; when we alſo conſider, that the higher parts of our atmoſphere are continually in a ſtrongly electrified ſtate; the analogy becomes ſo ſtrong, that we can ſcarce doubt of the aurora borealis ariſing from the ſame cauſe. The only difficulty is, to give a good reaſon why the electricity of the atmoſphere ſhould be conſtantly found to direct its courſe from the poles towards the equator, and not from the equator to the poles; and this we think may be done in the following manner. Aurora Borealis.

1. It is found that all electric bodies, when conſiderably heated, become conductors of electricity; thus hot air, hot glaſs, melted roſin, ſealing wax, &c. are all conductors, till their heat is diſſipated, and then they again become electrics. See *Electricity* paſſim.

2. As the converſe of every true propoſition ought alſo to be true, it follows from the above one, that if electrics when heated become conductors, then non-electrics when ſubjected to violent degrees of cold ought to become electric. In one inſtance this has been verified by experience; water, which is a conductor when warm or not violently cooled, is found to become electric when cooled to 20° below 0 of Fahrenheit's thermometer. With regard to metallic ſubſtances, indeed, no experiments have as yet been made to determine whether their conducting power is affected by cold or not. Very probably we might not be able to produce ſuch a degree of cold as ſenſibly to leſſen their conducting power; but ſtill the analogy will hold; and, as we are by no means able to produce the greateſt degree of cold poſſible, reaſon will always ſuggeſt to us, that if a certain degree of cold changes one conductor into an electric, a ſufficient degree of it will alſo change all others into electrics.

3. If cold is ſufficient to change conducting ſubſtances into electrics, it muſt alſo increaſe the electric power of ſuch ſubſtances as are already electric; that is to ſay, very cold air, glaſs, roſin, &c. provided they are dry, will be more electric than when they are warmer. With regard to air, which is moſt to our preſent purpoſe, this is rendered extremely probable, by conſidering that clear froſty weather is of all others the moſt favourable for electric experiments. They may be made indeed to equal advantage almoſt in any ſtate of the atmoſphere, provided ſufficient pains is uſed, but in dry hard froſts they will ſucceed much more eaſily that at any other time.

Theſe three axioms being allowed, the cauſe of the aurora borealis is eaſily deduced from them. The air, all round the globe, at a certain height above its ſurface, is found to be exceedingly cold, and, as far as experiments have yet determined, exceedingly electrical alſo. The inferior parts of the atmoſphere between the tropics, are violently heated during the day-time by the reflection of the ſun's rays from the earth. Such air will therefore be a kind of conductor, and much more readily part with its electricity to the clouds and vapours floating in it, than the colder air towards the north and ſouth poles. Hence the prodigious appearances of electricity in theſe regions, ſhowing itſelf in thunder and other tempeſts of the moſt terrible kind. Immenſe quantities of the electric fluid are thus communicated to the earth, and the inferior warm atmoſphere having once exhauſted itſelf, muſt neceſſarily

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ceſſarily be recruited from the upper and colder region. This becomes very probable from what the French mathematicians obſerved when on the top of one of the Andes. They were often involved in clouds, which, ſinking down into the warmer air, appeared there to be highly electrified, and diſcharged themſelves in violent tempeſts of thunder and lightning; while, in the mean time, on the top of the mountain, they enjoyed a calm and ſerene ſky. In the temperate and frigid zones, the inferior parts of the atmoſphere never being ſo ſtrongly heated, do not part with their electricity ſo eaſily as in the torrid zone, and conſequently do not require ſuch recruits from the upper regions; but notwithſtanding the difference of heat obſerved in different parts of the earth near the ſurface, it is very probable that at conſiderable heights the degree of cold is nearly equal all round it. Were there a like equality in the heat of the under part, there could never be any conſiderable loſs of equilibrium in the electricity of the atmoſphere: but as the hot air of the torrid zone is perpetually bringing down vaſt quantities of electric matter from the cold air that lies directly above it; and as the inferior parts of the atmoſphere lying towards the north and ſouth poles do not conduct in any great degree; it thence follows, that the upper parts of the atmoſphere lying over the torrid zone will continually require a ſupply from the northern and ſouthern regions. This eaſily ſhows the neceſſity of an electric current in the upper parts of the atmoſphere from each pole towards the equator: and thus we are alſo furniſhed with a reaſon why the aurora borealis appears more frequently in winter than in ſummer; namely, becauſe at that time the electric power of the inferior atmoſphere is greater on account of the cold than in ſummer; and conſequently the abundant electricity of the upper regions muſt go almoſt wholly off to the equatorial parts, it being impoſſible for it to get down to the earth: hence alſo the aurora borealis appears very frequent and bright in the frigid zones, the degree of cold in the upper and under regions of the atmoſphere being much more nearly equal in theſe parts than in any other. In ſome parts of Siberia particularly, this meteor appears conſtantly from October to Chriſtmas, and its corruſcations are ſaid to be very terrifying. Travellers agree, that here the aurora borealis appears in greateſt perfection; and it is to be remarked, that Siberia is the coldeſt country on earth. In confirmation of this, it may alſo be obſerved, that, from the experiments hitherto made with the electrical kite, the air appears conſiderably more electrical in winter than in ſummer, though the clouds are known to be often moſt violently electrified in the ſummer time; a proof, that the electricity naturally belonging to the air is in ſummer much more powerfully drawn off by the clouds than in the winter, owing to the exceſs of heat in ſummer, as already obſerved.

A conſiderable difficulty, however, ſtill remains, from the upright poſition which the ſtreams of the aurora borealis are generally obſerved to have; whereas, according to the hypotheſis abovementioned, they ought rather to run directly from north to ſouth. This difficulty occured to Dr Halley: but he anſwers it by ſuppoſing his magnetic effluvia to paſs from one pole to another in arches of great circles, ariſing to a vaſt height above the earth, and conſequently darting from the places whence they aroſe almoſt like the radii of a circle; in which caſe, being ſent off in a direction nearly perpendicular to the ſurface of the earth, they muſt neceſſarily appear erect to thoſe who ſee them from any part of the ſurface, as is demonſtrated by mathematicians. It is alſo reaſonable to think that they will take this direction rather than any other, on account of their meeting with leſs reſiſtance in the very high regions of the air than in ſuch as are lower.

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But the greateſt difficulty ſtill remains: for we have ſuppoſed the equilibrium of the atmoſphere to be broken in the day-time, and reſtored only the night; whereas, conſidering the immenſe velocity with which the electric fluid moves, the equilibrium ought to be reſtored in all parts almoſt inſtantaneouſly; yet the aurora borealis never appears except in the night, although its brightneſs is ſuch as muſt ſometimes make it viſible to us did it really exiſt in the day-time.

In anſwer to this it muſt be obſerved, that though the paſſage of electricity through a good conductor is inſtantaneous, yet through a bad conductor it is obſerved to take ſome time in paſſing. As our atmoſphere therefore, unleſs very violently heated, is but a bad conductor of electricity; though the equilibrium in it is broken, it can by no means be inſtantaneouſly reſtored. Add to this, that as it is the action of the ſun which breaks the equilibrium, ſo the ſame action, extending over half the globe, prevents almoſt any attempt to reſtore it till night; when flaſhes ariſe from various parts of the atmoſphere, gradually extending themſelves with a variety of undulations towards the equator.

It now remains to explain only one particularity of the aurora borealis, namely, that its ſtreams do not always move with rapidity, ſometimes appearing quite ſtationary for a conſiderable time, and ſometimes being carried in different directions with a ſlow motion. To this indeed we can give no other reply, than that weak electric lights have been ſometimes obſerved to put on the ſame appearance at the ſurface of the earth; and much more may we ſuppoſe them capable of doing ſo at great heights above it, where the conductors are both fewer in number and much more imperfect. When M. de Romans was making experiments with an electric kite in Italy, a cylinder of blue light about four or five inches diameter was obſerved ſurrounding the ſtring. This was in the day-time; but had it been night, he imagined it muſt have been four or five feet in diameter; and as the ſtring was 780 feet long, it would probably have ſeemed pyramidal, pointing upwards like one of the ſtreams of the aurora borealis. A ſtill more remarkable appearance, Dr Prieſtly tells us, was obſerved by Mr Hartman. He had been making electrical experiments for four or five hours together in a very ſmall room; and upon going out of it, and returning with a light in his hand, walking pretty quick, he perceived a ſmall flame following him at about three feet diſtance. Being alarmed at this appearance, he ſtopped to examine it, upon which it vaniſhed. This laſt inſtance is very remarkable, and ſingular in its kind: from both, however, we are ſufficiently warranted to conclude, that ſmall portions of our atmoſphere may by various cauſes be ſo much electri-

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fied as to ſhine, and likewiſe be moved from one place to another without parting with the electricity they have received, for a conſiderable time.

The corona, or circle, which is often formed near the zenith by the aurora borealis, is eaſily accounted for in the ſame manner. As this corona is commonly ſtationary for ſome time, we imagine it would be a very proper mark whereby to determine the diſtance of the meteor itſelf. If an aurora borealis, for inſtance, was obſerved by two perſons, one at London, and the other at Edinburgh; by noting the ſtars among which the corona was obſerved at each place, its true altitude from the ſurface of the earth could eaſily be determined by trigonometry.

Under the article ATMOSPHERE it was ſuggeſted, that no good proof had been as yet brought for the extreme rarity of the air uſually ſuppoſed to take place at no very great heights above the earth. The brightneſs of the meteor there mentioned at 70 miles perpendicular from the ſurface, as alſo its figure, ſeemed to prove the air conſiderably denſer at that diſtance from the earth. Though the height of the aurora borealis has never been determined, we can ſcarce imagine it to be greater than that of this meteor, or indeed ſo great: but although its ſtreams reſemble the paſſage of electric light through a vacuum, it cannot be from thence inferred, that the air is at all in a ſtate ſimilar to the vacuum of an air-pump in thoſe places where the aurora borealis is produced; ſeeing we have inſtances of ſimilar appearances being produced in very denſe air. The plate of an electrophorus is often ſo highly electrified, as to throw out flaſhes from different parts as ſoon as it is lifted up, and by proper management it may be always made to emit long and broad flaſhes which ſhall ſcarcely be felt by the finger, inſtead of ſmall, denſe, and pungent ſparks; ſo that, though long flaſhes may be produced in rarefied air, it by no means follows that the ſame may not alſo be produced in denſer air. As little can we infer any thing from the colours; for we obſerve the electric ſpark ſometimes white, ſometimes blue, and ſometimes purple, in the very ſame ſtate of the atmoſphere, and from the ſame ſubſtance.

The aurora borealis is ſaid to be attended with a peculiar hiſſing noiſe in ſome very cold climates; Gmelin ſpeaks of it in the moſt pointed terms, as frequent and very loud in the north-eaſtern parts of Siberia; and other travellers have related ſimilar facts. Gmelin's account is very remarkable. "Theſe northern lights (ſays he) begin with ſingle bright pillars, riſing in the N. and almoſt at the ſame time in the N. E. which gradually increaſing comprehend a large ſpace of the heavens, ruſh about from place to place with incredible velocity, and finally almoſt cover the whole ſky up to the zenith. The ſtreams are then ſeen meeting together in the zenith, and produce an appearance as if a vaſt tent was expended in the heavens, glittering with gold, rubies, and ſaphire. A more beautiful ſpectacle cannot be painted; but whoever ſhould ſee ſuch a northern light for the firſt time, could not behold it without terror. For however fine the illumination may be, it is attended, as I have learned from the relation of many perſons, with ſuch a hiſſing, cracking, and ruſhing noiſe throughout the air, as if the largeſt fireworks were playing off. To deſcribe what they then hear, they make uſe of the expreſſion, *Spolochi chodjat*, that is, the ranging hoſt is paſſing. The hunters who purſue the white and blue foxes in the confines of the Icy Sea, are often overtaken in their courſe by theſe northern lights. Their dogs are then ſo much frightened, that they will not move, but lie obſtinately on the ground till the noiſe has paſſed. Commonly clear and calm weather follows this kind of northern lights. I have heard this account, not from one perſon only, but confirmed by the uniform teſtimony of many, who have ſpent part of ſeveral years in theſe very northern regions, and inhabited different countries from the Yeneſei to the Lena; ſo that no doubt of its truth can remain. This ſeems indeed to be the real birth-place of the *aurora borealis*."

Aurora Borealis.

The hiſſing or ruſhing noiſe above deſcribed, Dr Blagden is inclined to attribute to ſmall ſtreams of electric matter running off to the earth from the maſſes or accumulations of electricity by which the northern lights are ſuppoſed to be produced.

6 Aurora borealis ſucceeded by ſouth-weſt winds.

We ſhall conclude this article with an account of a paper preſented to the Royal Society by Mr Winn, in 1772, wherein he ſays that the appearance of an aurora borealis, is a certain ſign of an hard gale of wind from the ſouth to ſouth-weſt. This he never found to fail in 23 inſtances; and even thinks, that from the ſplendor of the meteor, ſome judgment may be formed concerning the enſuing tempeſt. If the aurora is very bright, the gale will come on within twenty-four hours, but will be of no long duration; if the light is faint and dull, the gale will be leſs violent, and longer in coming on, but will alſo laſt longer. His obſervations were made in the Engliſh channel, where ſuch winds are very dangerous; and by attending to the auroræ, he ſays he often got eaſily out of it, when others narrowly eſcaped being wrecked. This is an exceeding uſeful obſervation for ſailors: but it cannot be expected that the winds ſucceeding theſe meteors ſhould in all places blow from the ſouth-weſt; though no doubt a careful obſervation of what winds ſucceed the aurora borealis, and other meteors, in different parts of the world, might contribute in ſome meaſure to leſſen the dangers of navigation.

7 Conjecture concerning the reaſon.

That the aurora borealis ought to be ſucceeded by winds, may be eaſily deduced from the hypotheſis laſt mentioned. If this phenomenon is occaſioned by the vaſt quantity of electric matter conveyed to the equatorial parts of the earth, it is certain that the earth cannot receive any great quantity of this matter at one place without emitting it at another. The electricity, therefore, which is conſtantly received at the equator, muſt be emitted nearer the poles, in order to perform its courſe, otherwiſe there could not be a conſtant ſupply of it for the common operations of nature. It is obſerved, that electrified bodies are always ſurrounded by a blaſt of air, which is ſent forth from them in all directions; hence, if the electric matter find a more ready paſſage through one part of the earth than another, a wind will be found to blow from that quarter. If therefore one of theſe places happens to be in the Atlantic ocean near the coaſt of France, or in the bay of Biſcay, the electric matter which has been received at the equator during an aurora borealis will be diſcharged there ſome time after, and conſequently a wind will blow from that quarter, which will be from the ſouth-weſt to thoſe ſhips which are in the Engliſh channel.

Aurum | Auſona.

channel. It cannot be imagined, however, that all the matter can be diſcharged from one place; and therefore according to the different ſituations of thoſe electrical vents, winds may blow in different directions; and thus the ſame aurora borealis may produce a ſouth-weſt wind in the Engliſh channel, and a north-weſt one in Scotland.

AURUM. See GOLD, CHEMISTRY, and METALLURGY.

This metal was introduced into medicine by the Arabians, who eſteemed it one of the greateſt cordials and comforters of the nerves. From them Europe received it without any diminution of its character; in foreign pharmacopœias it is ſtill retained, and even mixed with the ingredients from which ſimple waters are to be diſtilled. But no one, it is preſumed, at this time expects any ſingular virtues from it, ſince it certainly is not alterable in the human body. Mr Geoffroy, though unwilling to reject it from the cordial preparations, honeſtly acknowledges that he has no other reaſon for retaining it than complaiſance to the Arabian ſchools. The chemiſts have endeavoured, by many elaborate proceſſes, to extract what they call a ſulphur or anima of gold: but no method is as yet known of ſeparating the component parts of this metal; all the tinctures of it, and aurum potabile, which have hitherto appeared, are real ſolutions of it in aqua regia, diluted with ſpirit of wine or other liquors, and prove injurious to the body rather than beneficial. A place, however, is now given in ſome of the foreign pharmacopœias to the aurum fulminans; and it has of late been recommended as a remedy in ſome convulſive diſeaſes, particularly in the chorea ſancti viti.

AURUM Fulminans. See CHEMISTRY-*Index*.

AURUM Moſaicum. See CHEMISTRY-*Index*.

AURUNCI (anc. geog.), a people of Latium, towards Campania; the ſame with the Auſones, at leaſt ſo intermixed as not to be eaſily diſtinguiſhable, though Pliny ſeparates them.

AUSA, a town of Terraconenſis, in the middle age called *Auſona*; now *Vich de Oſona*, a town of Catalonia in Spain. E. Long. 2. N. Lat. 41. 50.

AUSCH. See AUCH.

AUSI, an ancient and very ſavage people of Libya. Herodotus tells us that they were unacquainted with marriage, and had all their women in common. The children were brought up by their mothers till they were able to walk: after which they were introduced to an aſſembly of the men, who met every three months; and the man to whom any child firſt ſpoke, acknowledged himſelf its father. They celebrated annually a feaſt in honour of Minerva, in which the girls divided into two companies, fought with ſticks and ſtones, and thoſe who died of their wounds were concluded not to have been virgins.

AUSIMUM, or AUXIMUM, an ancient Roman colony in the Picenum; now *Oſimo* or *Oſmo*, in the March of Ancona in Italy. E. Long. 15. N. Lat. 43. 20.

AUSITÆ, or ÆSITÆ, a tribe of ancient Arabs, ſuppoſed by Bochart to have inhabited the land of Uz mentioned in ſcripture.

AUSONA (anc. geog.), a town of the Auſones, a people who anciently occupied all the Lower Italy, from the Promontorium Circæum down to the ſtraits of Sicily (Livy), but were afterwards reduced to a much narrower compaſs; namely, between the Montes Circæi and Maſſici: nor did they occupy the whole of this, but other people were intermixed. Concerning Auſona or its remains there is nothing particular recorded. Auſonia. | Auſter.

AUSONIA, the ancient name of Italy, from its moſt ancient inhabitants the Auſones, (Virgil, Servius).

AUSONEUM MARE (anc. geog.), a part of the Ionian ſea, extending ſouthwards from the promontory Japygium to Sicily, which it waſhes on the eaſt, as it does the Brutii and Magna Græcia on the ſouth and eaſt. It is ſeparated from the Tuſcan ſea by the ſtrait of Meſſina.

AUSONIUS (in Latin *Decius*, or rather *Decimus*, Magnus Auſonius), one of the beſt poets of the fourth century, was the ſon of an eminent phyſician, and born at Bordeaux. Great care was taken of his education, the whole family intereſting themſelves in it, either becauſe his genius was very promiſing, or that the ſcheme of his nativity, which had been caſt by his grandfather on the mother's ſide, made them imagine that he would riſe to great honour. He made an uncommon progreſs in claſſical learning, and at the age of 30 was choſen to teach grammar at Bourdeax. He was promoted ſome time after to be profeſſor of rhetoric; in which office he acquired ſo great a reputation, that he was ſent for to court to be preceptor to Gratian the emperor Valentinian's ſon. The rewards and honours conferred on him for the faithful diſcharge of his office prove the truth of Juvenal's maxim, that when fortune pleaſes ſhe can raiſe a man from a rhetorician to the dignity of a conſul. He was actually appointed conſul by the emperor Gratian, in the year 379, after having filled other conſiderable poſts; for beſides the dignity of queſtor, to which he had been nominated by Valentinian, he was made prefect of the Prætorium in Italy and Gaul after that prince's death. His ſpeech returning thanks to Gratian on his promotion to the conſulſhip is highly commended. The time of his death is uncertain; he was ſtill living in 392, and lived to a great age. The emperor Theodoſius had a great eſteem for Auſonius, and preſſed him to publiſh his poems. There is a great inequality in his works; and in his manners and his ſtyle there is a harſhneſs which was perhaps rather the defect of the times he lived in than of his genius. Had he lived in Auguſtus's reign, his verſes, according to good judges, would have equalled the moſt finiſhed of that age. He is generally ſuppoſed to have been a Chriſtian: ſome ingenious authors indeed think otherwiſe, but, according to Mr Bayle, without juſt reaſon. The beſt edition of his poems is that of Amſterdam in 1671.

AUSPEX, a name originally given to thoſe who were afterwards denominated *augurs*. In which ſenſe the word is ſuppoſed to be formed from *avis*, "bird," and *inſpicere*, "to inſpect;" *auſpices*, q. d. *aviſpices*. Some will therefore have auſpices properly to denote thoſe who foretold future events from the ſight of birds.

AUSPICIUM, AUSPICY, the ſame with augury.

AUSTER, one of the four cardinal winds, as Ser-

vius

Auſtere] Auſtria.

vius calls them blowing from the ſouth, (Pliny, Ovid, Manilius).

AUSTERE, rough, aſtringent. Thus an auſtere taſte is ſuch a one as conſtringes the mouth and tongue; as that of unripe fruits, harſh wines, &c.

AUSTERITY, among moral writers, implies ſeverity and rigour. Thus we ſay *Auſterity of manners, auſterities of the monaſtic life, &c.*

AUSTIN, (St). See *St* AUGUSTIN.

AUSTRAL, AUSTRALIS, the ſame with ſouthern. The word is derived from *auſter*, "ſouth wind." Thus auſtral ſigns are the ſix laſt ſigns of the zodiac; ſo called becauſe they are on the ſouth ſide of the equinoctial.

AUSTRALIS PISCES, the SOUTHERN FISH, is a conſtellation of the ſouthern hemiſphere, not viſible in our latitude; whoſe ſtars in Ptolemy's catalogue are 18, and in the Britannic catalogue 24.

AUSTRIA, one of the principle provinces of the empire of Germany towards the eaſt; from which ſituation is takes its name *Ooſt-ryck*, in the German language ſignifying the *Eaſt Country*. It is bounded on the north by Moravia; on the eaſt by Hungary; on the ſouth by Stiria; and on the weſt by Bavaria. It is divided into *Upper* and *Lower*. Upper Auſtria is ſituated on the ſouth, and Lower Auſtria on the north, ſide of the Danube. Vienna the capital is in the Upper Auſtria, which contains ſeveral other very conſiderable towns. The country is very fertile, has a great many mines, and produces vaſt quantities of ſulphur.

In the ninth and tenth centuries, Auſtria was the frontier of the empire againſt the barbarians. In 928, the emperor Henry the Fowler, perceiving that it was of great importance to ſettle ſome perſon in Auſtria who might oppoſe theſe incurſions, inveſted Leopold, ſurnamed the *Illuſtrious*, with that country. Otho I. erected Auſtria into a marquiſate in favour of his brother-in-law Leopold, whoſe deſcendant Henry II. was created duke of Auſtria by the emperor Frederic Barbaroſſa. His poſterity became extinct in 1240, the ſtates of the country, in order to defend themſelves from the incurſions of the Bavarians and Hungarians, reſolved to put themſelves under the protection of Henry marquis of Miſnia; but Othogar II. king of Bohemia, being likewiſe invited by a party in the duchy took poſſeſſion of it, alledging not only the invitation of the ſtates, but alſo the right of his wife, heireſs of Frederic the laſt duke. The emperor Rodolphus I. pretending a right to this duchy, refuſed to give Othogar the inveſtiture of it; and afterwards killing him in battle, procured the right of it to his own family. From this Rodolphus the preſent houſe of Auſtria is deſcended, which for ſeveral centuries paſt has rendered itſelf ſo famous and ſo powerful, having given 14 emperors to Germany, and ſix kings to Spain.

In 1477, Auſtria was erected into an archduchy by the emperor Frederic the Pacific, for his ſon Maximilian, with theſe privileges: That theſe ſhall be judged to have obtained the inveſtiture of the ſtates, if they do not receive it after having demanded it three times; that if they receive it from the emperor, or the imperial ambaſſadors, they are to be on horſeback, clad in a royal mantle, having in their hand a ſtaff of command, and upon their head a ducal crown of two points, and ſurrounded with a croſs like that of the imperial crown. The arch-duke is born privy-counſellor to the emperor, and his ſtates cannot be put to the ban of the empire. All attempts againſt his perſon are puniſhed as crimes of leſemajeſty, in the ſame manner as thoſe againſt the king of the Romans, or Electors. No one dared to challenge him to ſingle combat. It is in his choice to aſſiſt at the aſſemblies, or to be abſent; and he has the privilege of being exempt from contributions and public taxes, excepting 12 ſoldiers which he is obliged to maintain againſt the Turk for one month. He has rank immediately after the electors; and exerciſes juſtice in his ſtates without appeal, by virtue of a privilege granted by Charles V. His ſubjects cannot even be ſummoned out of his province upon account of lawſuits, to give witneſs, or to receive the inveſtiture of fiefs. Any of the lands of the empire may be alienated in his favour, even thoſe that are feudal; and he has a right to create counts, barons, gentlemen, *poets*, and notaries. In the ſucceſſion to his ſtates, the right of birth takes place; and, failing males, the females ſucceed according to the lineal right; and if no heir be found, they may diſpoſe of their lands as they pleaſe. Auſtria.

Upper Auſtria, properly ſo called, has throughout the appearance of a happy country; here are no ſigns of the ſtriking contraſt betwixt poverty and riches which offends ſo much in Hungary. All the inhabitants, thoſe of the capital only excepted, enjoy that happy mediocrity which is the conſequence of a gentle and wiſe adminiſtration. The farmer has property; and the rights of the nobility, who enjoy a kind of lower judicial power, are well defined. The ſouth and ſouth-weſt parts of the country are bounded by a ridge of hills, the inhabitants of which enjoy a ſhare of proſperity unknown to thoſe of the interior parts of France. There are many villages and market-towns, the inhabitants of which have bought themſelves off from vaſſalage, are now their own governors, and belong ſome of them to the eſtates of the country. The cloiſters, the prelates of which belong to the eſtates of the country, are the richeſt in Germany, after the immediate prelacies and abbacies of the empire. One of the great convents of Benedictines is worth upwards of 4000 millions of French livres, half of which goes to the exchequer of the country.

Lower Auſtria yearly exports more than two millions worth of guilders of wine to Moravia, Bohemia, Upper Auſtria, Bavaria, Saltzburg, and part of Stiria and Carinthia. This wine is ſour, but has a great deal of ſtrength, and may be carried all over the world without danger; when it is ten or twenty years old it is very good. This country is very well peopled. Mr Schloſſer, in his political journal, which contains an account of the population of Auſtria, eſtimates that of this country at 2,100,000 men. The revenue of this country is about 14,000,000 florins; of which the city of Vienna contributes about five, as one man in the capital earns as much as three in the country.

The ſouthern parts of Auſtria are covered with hills, which riſe gradually from the banks of the Danube to the borders of Stiria, and are covered with woods. They loſe themſelves in the maſs of mountains which run to the ſouth of Germany, and ſtretch through all Stiria, Carniola, Carinthia, and Tyrol, to the Swiſs Alps; and are probably, after Savoy and Switzerland,

Auſtria. Auſtromancy.

the higheſt part of the earth. The inhabitants of this extenſive ridge of mountains are all very much alike; they are a ſtrong, large, and, the GOITRES excepted, a very handſome people.

The characteriſtic of the inhabitants of all this country is ſtriking bigotry, united with ſtriking ſenſuality. You need only ſee what is going forwards here to be convinced that the religion taught by the monks is as ruinous for the morals as it is repugnant to Chriſtianity. The Ciciſbeos accompany the married women from their bed to church, and lead them to the very confeſſional. The bigotry of the public in the interior parts of Auſtria, which from the mixture of gallantry with it, is ſtill to be found even amongſt people of rank, degenerates amongſt the common people into the groſſeſt and moſt abominable buffoonery. The Windes, who are mixed with the Germans in theſe countries, diſtinguiſh themſelves by a ſuperſtitious cuſtom that does little honour to the human underſtanding, and would be incredible if we had not the moſt unequivocal proofs of the fact before our eyes. Many years ago, they ſet out in company with ſome Hungarian enthuſiaſts to Cologne on the Rhine, which is about 120 German miles diſtant, to cut off the beard of a crucifix there. Every ſeven years this operation is repeated, as in this ſpace of time the beard grows again to its former length. The rich perſons of the aſſociation ſend the poorer ones as their deputies, and the magiſtrates of Cologne receive them as embaſſadors from a foreign prince. They are entertained at the expence of the ſtate, and a counſellor ſhews them the moſt remarkable things in the town. This farce brings in large ſums of money at ſtated times, and may therefore deſerve political encouragement; but ſtill, however, it is the moſt miſerable and meaneſt way of gain that can be imagined. Theſe Windes have alone the right to ſhave our Saviour, and the beard grows only for them. They firmly believe, that if they did not do this ſervice to the crucifix, the earth would be ſhut to them for the next ſeven years, and there would be no harveſts. For this reaſon they are obliged to carry the hair home with them, as the proof of having fulfilled their commiſſion, the returns of which are diſtributed amongſt the different communities, and preſerved as holy reliques. The Imperial court has for a long time endeavoured in vain to prevent this emigration, which deprives agriculture of ſo many uſeful hands. When the Windes could not go openly, they would go clandeſtinely. At length the court thought of the expedient of forbidding the regency of Cologne to let them enter the town. This happened ſix years ago, and the numerous embaſſy was obliged to beg its way back again without the wonderful beard; which without doubt the Capuchins, to whom the crucifix belonged, uſed to put together from their own. The trade which the monks carry on with holy ſalves, oils, &c. is ſtill very conſiderable; a prohibition of the court, lately publiſhed has rather leſſened it, but it cannot be entirely ſuppreſſed till next generation. It is now carried on ſecretly, but perhaps to nearly as great an amount as formerly.

AUSTROMANCY, AUSTROMANTIA, properly denotes ſoothſaying, or a vain method of predicting futurity, from obſervations of the winds.

AUTERFOITS ACQUIT. } See the article *PLEA* to
AUTERFOITS Attaint. } *Indictment.*
AUTERFOITS Convict. }

Auterfoits | Autograph

AUTHENTIC, ſomething of acknowledged and received authority. In law, it ſignifies ſomething cloathed in all its formalities, and atteſted by perſons to whom credit has been regularly given. Thus we ſay, *authentic papers, authentic inſtruments.*

AUTHOR, properly ſignifies one who created or produced any thing. Thus God, by way of eminence, is called the *Author of nature*, the *Author of the univerſe.*

AUTHOR, in matters of literature, a perſon who has compoſed ſome book or writing.

AUTHORITY, in a general ſenſe, ſignifies a right to command, and make one's ſelf obeyed. In which ſenſe, we ſay, *the royal authority, the epiſcopal authority, the authority of a father*, &c. It denotes alſo the teſtimony of an author, ſome apophthegm or ſentence of an eminent perſon quoted in a diſcourſe by way of proof.

Authority is repreſented, in painting, like a grave matron ſitting in a chair of ſtate, richly clothed in a garment embroidered with gold, holding in her right-hand a ſword, and in her left a ſceptre. By her ſide is a double trophy of books and arms.

AUTOCHTHONES, an appellation aſſumed by ſome nations, importing that they ſprung, or were produced, from the ſame ſoil which they ſtill inhabited. In this ſenſe, *Autochthones* amounts to the ſame with *Aborigines*. The Athenians valued themſelves on their being Autochthones, *ſelf-born*, or γηγενεις, *earth-born*; it being the prevailing opinion among the ancients, that, in the beginning, the earth, by ſome prolific power, produced men, as it ſtill does plants. The proper Autochthones were thoſe primitive men who had no other parent beſides the earth. But the name was alſo aſſumed by the deſcendants of theſe men, provided they never changed their ancient ſeat, nor ſuffered other nations to mix with them. In this ſenſe it was that the Greeks, and eſpecially the Athenians, pretended to be Autochthones; and, as a badge thereof, wore a gold graſshopper woven in their hair, an inſect ſuppoſed to have the ſame origin.

AUTOCRATER, a perſon veſted with an abſolute independent power, by which he is rendered unaccountable to any other for his actions. The power of the Athenian generals, or commanders, was uſually limited; ſo that at the expiration of their office, they were liable to render an account of their adminiſtration. But, on ſome extraordinary occaſions, they were exempted from this reſtraint, and ſent with a full and uncontroulable authority: in which caſe they were ſtyled Αυτοκρατορες. The ſame people alſo applied the name to ſome of their ambaſſadors, who were veſted with a full power of determining matters according to their own diſcretion. Theſe were denominated Πρεσβεις Αυτοκρατορες, and reſembled our plenipotentiaries.

AUTO DA FE, act of faith. See ACT *of Faith.*

AUTODIDACTUS, a perſon ſelf-taught, or who has had no maſter, or aſſiſtant of his ſtudies, beſides himſelf.

AUTOGRAPH, denotes a perſon's hand-writing, or the original manuſcript of any book, &c.

AUTO-

Autolithotomus ‖ Autonomia

AUTOLITHOTOMUS, he who cuts himſelf for the ſtone. Of this we have a very extraordinary inſtance given by Reiſelius, in the Ephemerides of the Academy *Naturæ Curioſorum*, dec. 1. an. 3. obſ. 192.

AUTOMATE, called alſo *Hiera*, one of the Cyclades, an iſland to the north of Crete (Pliny), ſaid to have emerged out of the ſea, between the iſlands Thera and Therasia, in the fifth year of the emperor Claudius; in extent thirty ſtadia, (Oroſius).

AUTOMATON (from αυτος, *ipſe* and ματμαι *excitor*), a ſelf-moving machine, or one ſo conſtructed, by means of weights, levers, pullies, &c. as to move for a conſiderable time, as though endued with animal life. According to this deſcription, clocks, watches, and all machines of that kind, are automata.

Under the article ANDROIDES, we obſerved that the higheſt perfection to which automata could be carried was to imitate exactly the motions and actions of living creatures, eſpecially of mankind, which are more difficultly imitated than thoſe of other animals. Very ſurpriſing imitations, however, have been made of other creatures. So long ago as 400 years before Chriſt, Archytas of Tarentum is ſaid to have made a wooden pigeon that could fly; nor will this appear at all incredible, when we conſider the flute-player made by M. Vaucanſon, and the cheſs-player by M. Kempell. Dr Hook is alſo ſaid to have made the model of a flying chariot, capable of ſupporting itſelf in the air. But M. Vaucanſon abovementioned hath diſtinguiſhed himſelf ſtill more eminently. That gentleman, encouraged by the favourable reception of his flute-player, made a duck, which was capable of eating, drinking, and imitating exactly the voice of a natural one. Nay, what is ſtill more ſurpriſing, the food it ſwallowed was evacuated in a digeſted ſtate; not that it was really in a ſtate of natural excrement, but only conſiderably altered from what it was when ſwallowed; and this digeſtion was performed on the principles of ſolution, not of trituration. The wings, viſcera, and bones, of this artificial duck, were alſo formed ſo as very ſtrongly to reſemble thoſe of a living animal. Even in the actions of eating and drinking, this reſemblance was preſerved; the artificial duck ſwallowed with avidity and vaſtly quick motions of the head and throat; and likewiſe muddled the water with his bill, exactly like a natural one.

M. Le Droz of La Chaux de Fonds in the county of Neufchattel, hath alſo executed ſome very curious pieces of mechaniſm, which well deſerve to be ranked with thoſe already mentioned. One was a clock, which was preſented to his Spaniſh majeſty; and had, among other curioſities, a ſheep, which imitated the bleating of a natural one; and a dog watching a baſket of fruit: when any one attempted to purloin the fruit, the dog gnaſhed his teeth and barked; and if it was actually taken away, he never ceaſed barking till it was reſtored. Beſides this, he made a variety of human figures, which exhibited motions truly ſurpriſing; but all inferior to Mr Kempell's cheſs-player, which may juſtly be looked upon as the greateſt maſter-piece in mechanics that ever appeared. See ANDROIDES.

AUTONOMIA, a power of living or being governed by our own laws and magiſtrates. The liberty of the cities which lived under the faith and protection of the Romans, conſiſted in their autonomia, *i. e.* they were allowed to make their own laws, and elect their own magiſtrates; by whom juſtice was to be adminiſtered, and not by Roman preſidents or judges, as was done in other places which were not indulged the autonomia.

Autopyros ‖ Autun.

AUTOPYROS, from αυτος, and πυρος, *wheat*; in the *Ancient diet*, an epithet given to a ſpecies of bread, wherein the whole ſubſtance of the wheat was retained, without retrenching any part of the bran. Galen deſcribes it otherwiſe, viz. as bread where only the coarſer bran was taken out.—And thus it was a medium between the fineſt bread, called *ſimilagineus*, and the coarſeſt called *furfuraceus*. This was alſo called *autopyrites* and *ſyncomiſtus*.

AUTRE-EGLISE, a village of Brabant, in the Auſtrian Netherlands; to which the left wing of the French army extended, when the confederates obtained the victory at Ramillies, in 1706. E. Long. 4. 50. N. Lat. 50. 40.

AUTRICUM, the capital of the Carnutas, a people of Gallia Celtica; afterwards called *Carnotena*, *Carnotenus*, and *Civitas Carnotenum*: Now *Chartres*, in the Orleanois on the Eure. E. Long. 1. 32. N. Lat. 48. 47.

AUTUMN, the third ſeaſon of the year, when the harveſt and fruits are gathered in. Autumn is repreſented, in painting, by a man at perfect age, clothed like the vernal, and likewiſe girded with a ſtarry girdle; holding in one hand a pair of ſcales equally poiſed, with a globe in each; in the other hand, a bunch of divers fruits and grapes. His age denotes the perfection of this ſeaſon; and the balance, that ſign of the zodiac which the ſun enters when our autumn begins.

Autumn begins on the day when the ſun's meridian diſtance from the zenith, being on the decreaſe, is a mean between the greateſt and the leaſt; which in theſe countries is ſuppoſed to happen when the ſun enters Libra. Its end coincides with the beginning of winter. Several nations have computed the years by autumns: the Engliſh Saxons, by winters. Tacitus tells us, the ancient Germans were acquainted with all the other ſeaſons of the year, but had no notion of Autumn. Lidyat obſerves of the beginning of the ſeveral ſeaſons of the year, that

Dat Clemens hyemem, dat Petres ver cathedratus,
Æſtuat Urbanus, autumnat *Bartholomæus.*

Autumn has always been reputed an unhealthy ſeaſon, Tetullian calls it *tentator valetudinum*: and the ſatyriſt ſpeaks of it in the ſame light, *Autumnus Libitinæ quæſtus acerbæ.*

AUTUMNAL POINT, is that part of the equinox from which the ſun begins to deſcend towards the ſouth pole.

AUTUMNAL Signs, in aſtronomy, are the ſigns Libra, Scorpio, Sagittarius, through which the ſun paſſes during the autumn.

AUTUMNAL Equinox, that time when the ſun enters the autumnal point.

AUTUN, an ancient city of France in the duchy of Burgundy, the capital of the Autonois, with a biſhop's ſee. The length of this city is about three quarters of a mile, and its breadth nearly equal. The river Arroux waſhes its ancient walls, whoſe ruins are ſo firm, and the ſtones ſo cloſely united, that they ſeem almoſt to be cut out of the ſolid rock. In this city are the ruins

of

Autura | Auxy.

of three ancient temples, one of which was dedicated to Janus, and another to Diana. Here are likewiſe a theatre and a pyramid, which laſt is probably a tomb; it ſtands in a place called the *field of urns*, becauſe ſeveral urns had been found there. Here are alſo two antique gates of great beauty. The city lies at the foot of three great mountains, in E. Long. 4. 15. N. Lat. 45. 50.

AUTURA, or AUDURA, a river of Gallia Celtica, only mentioned in the lives of the ſaints. Now the *Eure*, which falls into the Seine, on the left-hand or ſouth ſide.

AUVERGNE, a province of France, about 100 miles in length and 75 in breadth. It is bounded on the north, by the Bourbonnois; on the eaſt, by Torez and Velay; on the weſt, by Limoſin, Quercy, and La Marche; and on the ſouth, by Rovergne and the Cevennes. It is divided into upper and lower; the latter, otherwiſe called *Limagne*, is one of the fineſt countries in the world. The mountains of Higher Auvergne render it leſs fruitful; but they afford good paſture, which feeds great numbers of cattle, which are the riches of that country. Auvergne ſupplies Lyons and Paris with fat cattle, makes a large quantity of cheeſe, and has manufactures of ſeveral kinds. The capital of the whole province is Clermont.

AUVERNAS, a very deep-coloured heady wine, made of black raiſins ſo called, which comes from Orleans. It is not fit to drink before it is above a year old; but if kept two or three years, it becomes excellent.

AUXERRE, an ancient town of France in the duchy of Burgandy, and capital of the Auxerrois, with a biſhop's ſee. The epiſcopal palace is one of the fineſt in France, and the churches are alſo very beautiful. This town is advantageouſly ſituated for trade with Paris, on the river Yone. E. Long. 3. 35. N. Lat. 47. 54

AUXESIS, in mythology, a goddeſs worſhipped by the inhabitants of Egina, and mentioned by Herodotus and Pauſanias.

AUXESIS, in rhetoric, a figure whereby any thing is magnified too much.

AUXILIARY, whatever is aiding or helping to another.

Auxiliary Verbs, in grammar, are ſuch as help to form or conjugate others; that is, are prefixed to them, to form or denote the moods or tenſes thereof: as, *to have* and *to be*, in the Engliſh; *etre* and *avoir*, in the French; *ho* and *ſono* in the Italian, &c. In the Engliſh language, the auxiliary verb *am* ſupplies the want of paſſive verbs.

AUXO, in mythology, the name of one of two Graces worſhipped by the Athenians. See HEGEMONE.

AUXONNE, a ſmall fortified town of France, in the duchy of Burgundy; ſeated on the river Saone, over which there is a bridge of 23 arches, to facilitate the running off of the waters after the overflowing of the river. At the end of the bridge is a cauſway 2250 paces long. E. Long. 5. 22. N. Lat. 47. 11.

AUXY; the French give the name of *auxy wool* to that which is ſpun in the neighbourhood of Abbeville, by thoſe workmen who are called *houpiers*. It is a very fine and beautiful wool, which is commonly uſed to make the fineſt ſtockings.

Award | Axholm.

AWARD, in law, the judgment of an arbitrator, or of one who is not appointed by the law a judge, but choſen by the parties themſelves for terminating their differences. See ARBITER and ARBITRATION.

AWL, among ſhoemakers, an inſtrument wherewith holes are bored through the leather, to facilitate the ſtitching or ſewing the ſame. The blade of the awl is uſually a little flat and bended, and the point ground to an acute angle.

AWLAN, a ſmall imperial town of Germany, in the circle of Suabia, ſeated on the river Kochen. E. Long. 11. 15 N. Lat. 48. 52.

AWME, or AUME, a Dutch liquid meaſure containing eight ſteckans, or 20 verges or verteels, equal to the tierce in England, or to one-ſixth of a ton of France.

AWN, in botany. See ARISTA.

AWNING, in the ſea-language, is the hanging a ſail, tarpawling, or the like, over any part of the ſhip, to keep off the ſun, rain or wind.

AX, a carpenter's inſtrument, ſerving to hew wood. The ax differs from the joiner's hatchet, in that it is made larger and heavier, as ſerving to hew large ſtuff; and its edge tapering into the middle of its blade. It is furniſhed with a long handle or helve, as being to be uſed with both hands.

Battle-AX. See CELT.

AXAMENTA, in antiquity, a denomination given to the verſes or ſongs of the *ſalii*, which they ſung in honour of all men. The word is formed, according to ſome, from *axare*, q. d. *nominare*. Others will have the *carmina ſaliaria* to have been denominated *axamenta*, on account of their having been written in *axibus*, or on wooden tables.

The *axamenta* were not compoſed, as ſome have aſſerted, but only ſung by the *ſalii*. The author of them was Numa Pompilius; and as the ſtyle might not be altered, they grew in time ſo obſcure, that the *ſalii* themſelves did not underſtand them. Varro ſays they were 700 years old. Quint. Inſt. Or. lib. i. c. 11.

AXAMENTA, or *Aſſamenta*, in ancient muſic, hymns or ſongs performed wholly with human voices.

AXAYACATL, the name of a ſpecies of fly, common in Mexico, about the Lake; the eggs of which being depoſited in immenſe quantities, upon the ruſhes and corn-flags, form large maſſes, which are taken up by fiſhermen and carried to market for ſale. This caviare, called *ahuauhtli*, which has much the ſame taſte with the caviare of fiſh, uſed to be eat by the Mexicans, and is now a common diſh among the Spaniards. The Mexicans eat not only the eggs, but the flies themſelves, made up together into a maſs, and prepared with ſaltpetre.

AXATI, a town of ancient Bætica, in the Bœtis; now *Lora*, a ſmall city of Andaluſia, in Spain, ſeated on the Guadalquivir. W. Long. 5. 20. N. Lat. 37. 20.

AXBRIDGE, a town of Somerſetſhire in England, conſiſting of one long narrow ſtreet. W. Long. 2. 20 N. Lat. 51. 30.

AXEL, a ſmall fortified town in Dutch Flanders. E. Long. 3. 40. N. Lat. 51. 17.

AXHOLM, an iſland in the north-weſt part of Lincolnſhire in England. It is formed by the rivers Trent, Idel, and Dan; and is about ten miles long and five broad. The lower part is marſhy, but produces an odoriferous

Axiace ‖ Axinomancy.

odoriferous ſhrub called *gall*; the middle is rich and fruitful, yielding flax in great abundance, as alſo alabaſter which is uſed for making lime. The principal town is called *Axey*, and is now thinly inhabited.

AXIACE, an ancient town of Sarmatia Europea; now *Oxakow*, the capital of Budziac Tartary. E. Long. 32. 30. N. Lat. 46. 0.

AXILLA, in anatomy, the arm-pit, or the cavity under the upper part of the arm.

AXILLA, in botany, is the ſpace comprehended between the ſtems of plants and their leaves. Hence we ſay thoſe flowers grow in the axillæ of the leaves; *i.e.* at the baſe of the leaves, or juſt within the angle of their pedicles.

AXILLARY, ſomething belonging to or lying near the axilla. Thus, *axillary artery* is that part of the ſubclavian branches of the aſcending trunk of the aorta which paſſeth under the arm-pits; *axillary glands* are ſituated under the arm-pits, enveloped in fat, and lie cloſe by the axillary veſſels; and *axillary vein* is one of the ſubclavians which paſſes under the arm-pit, dividing itſelf into ſeveral branches, which are ſpread over the arm.

AXIM, a ſmall territory on the gold-coaſt in Africa. The climate here is ſo exceſſively moiſt, that it is proverbially ſaid to rain 11 months and 29 days of the year. This exceſſive moiſture renders it very unhealthy; but it produces great quantities of rice, water melons, lemons, oranges, &c. Here are alſo produced vaſt numbers of black cattle, goats, ſheep, tame pigeons, &c. The whole country is filled with beautiful and populous villages, and the intermediate lands well cultivated; beſides which, the natives are very wealthy, from the conſtant traffic carried on with them by the Europeans for their gold. The capital which is alſo called *Axim*, by ſome *Achombone*, ſtands under the cannon of the Dutch fort St Antonio. Behind, it is ſecured by a thick wood that covers over the whole declivity of a neighbouring hill. Between the town and the ſea runs an even and ſpacious ſhore of beautiful white ſand. All the houſes are ſeparated by groves of cocoa and other fruit trees, planted in parallel lines, each of an equal width, and forming an elegant viſta. The little river Axim croſſes the town; and the coaſt is defended by a number of ſmall pointed rocks, which project from the ſhore, and render all acceſs to it dangerous. The capital is ſituated in W. Long. 24. 0. N. Lat. 5.0. This canton is a kind of republic, the government being divided between the Caboceroes or chief men, and Manaceroes or young men. It muſt be obſerved, however, that in their courts there is not even a pretence of juſtice: whoever makes the moſt valuable preſents to the judges is ſure to gain his cauſe, the judges themſelves alledging the gratitude due for the bribes received as a reaſon: and if both parties happen to make preſents of nearly equal value, they abſolutely refuſe to give the cauſe a hearing.

AXINOMANCY, AXINOMANTIA, from *ἀξίνη*, *ſecuris*, and *μαντεία*, *divinatio*; an ancient ſpecies of divination, or a method of foretelling future events by means of an ax or hatchet.—This art was in conſiderable repute among the ancients; and was performed, according to ſome, by laying an agate-ſtone on a red-hot hatchet; and alſo by fixing a hatchet on a round ſtake ſo as to be exactly poiſed; then the names of thoſe that were ſuſpected were repeated, and he at whoſe name the hatchet moved was pronounced guilty.

Axiom ‖ Axminſter.

AXIOM, AXIOMA (from *ἀξιόω*, *I am worthy*); a ſelf-evident truth, or a propoſition whoſe truth every perſon receives at firſt ſight. Thus, that the whole is greater than a part; that a thing cannot be and not be at the ſame time; and that from nothing, nothing can ariſe; are axioms.

AXIOM is alſo an eſtabliſhed principle in ſome art or ſcience. Thus, it is an axiom in phyſics, that nature does nothing in vain; that effects are proportional to their cauſes, &c. So it is an axiom in geometry, that things equal to the ſame thing are alſo equal to one another; that if to equal things you add equals, the ſums will be equal, &c. It is an axiom in optics, that the angle of incidence is equal to the angle of reflection, &c.

AXIOPOLIS, a town of the Triballi in Mæſia Inferior; now *Axiopoli*, in Bulgaria. E. Long. 34. 0. N. Lat. 55. 40.

AXIS, in geometry, the ſtraight line in a plain figure, about which it revolves, to produce or generate a ſolid. Thus, if a ſemicircle be moved round its diameter at reſt, it will generate a ſphere, the axis of which is that diameter.

AXIS, in aſtronomy, is an imaginary right line ſuppoſed to paſs through the centre of the earth and the heavenly bodies, about which they perform their diurnal revolutions.

AXIS, in conic-ſections, a right line dividing the ſection into two equal parts, and cutting all its ordinates at right angles.

AXIS, in mechanics. The axis of a balance is that line about which it moves, or rather turns about. *Axis of oſcillation*, is a right line parallel to the horizon, paſſing through the centre about which a pendulum vibrates.

AXIS in Peritrochio, one of the ſix mechanical powers, conſiſting of a peritrochium or wheel concentric with the baſe of a cylinder, and moveable together with it about its axis.

AXIS, in optics, is that particular ray of light coming from any object which falls perpendicularly on the eye.

AXIS, in architecture. *Spiral axis*, is the axis of a twiſted column drawn ſpirally in order to trace the circumvolutions without. *Axis of the Ionic capital*, is a line paſſing perpendicularly through the middle of the eye of the volute.

Axis of a Veſſel, is an imaginary right line paſſing through the middle of it perpendicularly to its baſe, and equally diſtant from its ſides.

AXIS, in botany, is a taper column placed in the centre of ſome flowers or catkins, about which the other parts are diſpoſed.

AXIS, in anatomy, the name of the ſecond vertebra of the neck; it hath a tooth which goes into the firſt vertebra, and this tooth is by ſome called the *axis*.

AXMINSTER, a town of Devonſhire, ſituated on the river Ax, in the great road between London and Exeter in W. Long. 3. 15. N. Lat. 50. 40. It was a place of ſome note in the time of the Saxons, but now

contains

Axolotlf | Aylmer.

contains only about 200 houſes. Here is a ſmall manufactory of broad and narrow cloths, and ſome carpets are alſo manufactured after the Turky manner.

AXOLOTLF. See LACERTA.

AXUMA, formerly a large city, and capital of the whole kingdom of Abyſſinia in Africa, but now reduced to a miſerable village ſcarce containing 100 inhabitants. E. Long. 36. 4. N. Lat. 14. 13.

AXUNGIA, in a general ſenſe, denotes old lard, or the drieſt and hardeſt of any fat in the bodies of animals: but more properly it ſignifies only hog's lard.

AXUNGIA Vitri, Sandiver, or *Salt of Glaſs*, a kind of ſalt which ſeparates from the glaſs while it is in fuſion. It is of an acrimonious and biting taſte. The farriers uſe it for cleanſing the eyes of horſes. It is alſo made uſe of for cleanſing the teeth; and it is ſometimes applied to running ulcers, the herpes, or the itch, by way of deſiccative.

AXYRIS: A genus of the triandria order, belonging to the monœcia claſs of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. The calyx of the male is tripartite; it has no corolla. The calyx of the female conſiſts of two leaves; it has two ſtyli and one ſeed. The ſpecies are four, none of them natives of Britain.

AY, a town of France in Champagne, near the river Marne, remarkable for its excellent wines. E. Long. 2. 15. N. Lat. 49. 4.

AYAMONTE, a ſea-port town of Andaluſia in Spain, with a ſtrong caſtle built on a rock; ſeatedon the mouth of the river Guadiana. It has a commodious harbour, fruitful vineyards, and excellent wine. W. Long. 8. 5. N. Lat. 37. 9.

AYENIA, in botany: A genus of the pentandria order, belonging to the gynandria claſs of plants; and in the natural method ranking under the 37th order, *Columniferæ*. The calyx has two leaves; the petals are in the form of a ſtar, with long ungues; and the capſule has five cells. There are three ſpecies, all natives of the Weſt-Indies.

AYLESBURY. See AILESBURY. This place gave title of Earl to the noble family of Bruce, now to a branch of the Brudenals by ſucceſſion.

AYLMER (John), biſhop of London, in the reign of Queen Elizabeth, was born in the year 1521, at Aylmer-hall in the pariſh of Tilney, in the county of Norfolk. Whilſt a boy, he was diſtinguiſhed for his quick parts by the Marquis of Dorſet afterwards Duke of Suffolk; who ſent him to Cambridge, made him his chaplain, and tutor to his children. One of theſe children was the unfortunate Lady Jane Gray, who ſoon became perfectly acquainted with the Latin and Greek languages. His firſt preferment was to the Archdeaconry of Stow in the dioceſe of Lincoln, which gave him a ſeat in the convocation held in the firſt year of Queen Mary, where he reſolutely oppoſed the return to Popery, to which the generality of the clergy were inclined. He was ſoon after obliged to fly his country, and take ſhelter among the Proteſtants in Switzerland. On the acceſſion of Queen Elizabeth, he returned to England. In 1562, he obtained the archdeaconry of Lincoln; and was a member of the famous ſynod of that year, which reformed and ſettled the doctrine and diſcipline of the church of England. In the year 1576, he was conſecrated biſhop of London. He died in the year 1594, aged 73; and was buried in St Paul's. He was a learned man, a zealous father of the church, and a bitter enemy to the Puritans. He publiſhed a piece intitled, *An harbrowe for faithful and trewe ſubjects againſt the late blowne blaſte concerning the government of wemen*, &c. This was written whilſt he was abroad in anſwer to Knox, who publiſhed a book at Geneva under this title, *The firſt blaſt againſt the monſtrous regiment and empire of women*. He is by Strype ſuppoſed to have publiſhed Lady Jane Gray's letter to Harding. He alſo aſſiſted Fox in tranſlating his Hiſtory of Martyrs into Latin.

Ayry | Azalea.

AYRY, or AERY, *of Hawks*, a neſt or company of hawks; ſo called from the old French word *aire*, which ſignified the ſame.

AYSCUE (Sir George), a gallant Engliſh admiral, deſcended from a good family in Lincolnſhire. He obtained the honour of knighthood from King Charles I. which, however, did not with-hold him from adhering to the parliament in the civil war: he was by them conſtituted admiral of the Iriſh ſeas, where he is ſaid to have done great ſervice to the Proteſtant intereſt, and to have contributed much to the reduction of the whole iſland. In 1651 he reduced Barbadoes and Virginia, then held for the king, to the obedience of the parliament; and ſoon after the reſtoration behaved with great honour in the war with the Dutch. In the famous engagement in the beginning of June 1666, when Sir George was admiral of the white ſquadron, his ſhip the Royal Prince ran upon the Gallop-ſand; where being ſurrounded with enemies, his men obliged him to ſtrike. He went no more to ſea after this, but ſpent the reſt of his days in retirement.

AYMOUTH. See EYMOUTH.

AYTONIA, in botany: A genus of the monadelphia order, belonging to the pentandria claſs of plants; the characters of which are: The calyx is quinquepartite; the corolla conſiſts of four petals; the berry is dry, quadrangular, unilocular, and many-ſeeded. There is but one ſpecies, the capenſis, a native of the Cape, but of which we have found no particular deſcription.

AZAB, in the Turkiſh armies, a diſtinct body of ſoldiery, who are great rivals of the Janiſſaries.

AZAI, a town of Touraine in France, ſeated on the river Indre. E. Long. 10. 35. N. Lat. 47. 18.

AZALEA, AMERICAN UPRIGHT HONEYSUCKLE: A genus of the monogynia order, belonging to the pentandria claſs of plants: and in the natural method ranking under the 18th order, *Bicornes*. The corolla is bell-ſhaped; the ſtamina are inſerted into the receptacle; and the capſule has five cells. There are ſix ſpecies, of which the moſt remarkable are the following. 1. The viſcoſa, with a white flower, is a low ſhrub, ariſing with ſeveral ſtems to the height of two or three feet. The leaves come out in cluſters without any order at the end of the ſhoots, and their edges are ſet with very ſhort teeth which are rough. The flowers come out in cluſters between the leaves, have much the appearance of honeyſuckle, and are as well-ſcented. 2. The nudiflora, or red American upright honeyſuckle, grows taller than the firſt; and in its native country will ſometimes arrive at the height of 12 feet, but in Britain never riſes to above half that height. It hath ſeveral ſtems with oblong ſmooth leaves. The flower-ſtalks ariſe from the diviſion of the branches, which are long and naked,

Azamor | Azimuth.

naked, ſupporting a cluſter of red flowers: theſe are divided at the top into five equal ſegments which ſpread open. Another ſpecies with bright red flowers was found by Mr Lightfoot upon the tops of many mountains in the Highlands of Scotland.—The firſt two ſpecies require a moiſt ſoil and a ſandy ſituation, and can only be propagated from ſlips, as they never produce good ſeeds in Britain. The autumn is the beſt time to remove the plants, and their roots ought to be covered in winter. They are moſt beautiful plants, and well worth cultivating.

AZAMOR, a ſmall ſea-port town of the kingdom of Morocco in Africa. It is ſituated on the river Morbeya, in the province of Duguella, at ſome conſiderable diſtance from its mouth. This town, though formerly very conſiderable, is not proper for maritime commerce, becauſe the entrance of the river is dangerous. It was unſucceſsfully beſieged by the Portugueſe in 1508; it was taken, however, in 1513 by the Duke of Braganza, but abandoned about the end of the 16th century. W. Long. 7. 0. N. Lat. 32. 50.

AZARAKITES, a ſect of Mahometan Arabs. See ARABIA, nº 143, *et ſeq.*

AZARIAH, or UZZIAH, king of Judah, ſucceeded his father Amaziah, 810 years before Chriſt. He aſſembled an army of above 300,000 men, with which he conquered the Philiſtines, and demoliſhed the walls of Gath, Jabniel, and Aſhdod; built up the walls of Jeruſalem; furniſhed the city with conduits; and planted gardens and vineyards: but at laſt, being elated with his proſperity, and reſolving to uſurp the office of high prieſt, he was ſtruck with a leproſy, which obliged him to remain ſhut up in his palace for the reſt of his days. He died about 759 years before the Chriſtian æra, and was ſucceeded by Jonathan his ſon.—There are ſeveral other perſons of this name mentioned in the ſacred Scriptures.

AZAZEL. The word relates to the ſcape-goat, under the Jewiſh religion. Some call the goat itſelf by this name, as St. Jerom and Theodoret. Dr Spencer ſays, the ſcape-goat was to be ſent to Azazel; by which is meant the devil. M. le Clerc tranſlates it *præcipitium*, making it to be that ſteep and inacceſſible place to which the goat was ſent, and where it was ſuppoſed to periſh.

AZEKA, (anc. geog.) a city of the Amorrhites, in the lot of Judah; ſituated between Eleutheropolis and Aelia, (Jerome); where the five kings of the Amorrhites and their army were deſtroyed by hailſtones from heaven, (Joſhua).

AZEM, ASEM, ASSAM, or ACHEM, a country of Aſia to the north of Ava, but which is very little known to Europeans. It is ſaid to be very fertile, and to contain mines of gold, ſilver, iron, and lead, all which belong to the king, who, in conſequence of enjoying the produce, requires no taxes from his people. They have alſo great quantities of gum lac, and coarſe ſilk. It is alſo thought that the inhabitants of Azem were long ago the inventors of cannon and gun-power; and that from them the invention paſſed to the inhabitants of Pegu, and from thence to the Chineſe.

AZIMUTH, in aſtronomy, an arch of the horizon, intercepted between the meridian of the place and the azimuth, or vertical circle paſſing through the centre of the object, which is equal to the angle of the zenith, formed by the meridian and vertical circle: or it is found by this proportion. As the radius to the tangent of the latitude of the place, ſo is the tangent of the ſun's or ſtar's altitude, for inſtance, to the coſine of the azimuth from the ſouth, at the time of the equinox. Azimuth.

Magnetical AZIMUTH, an arch of the horizon intercepted between the azimuth, or vertical circle, paſſing through the centre of any heavenly body, and the magnetical meridian. This is found by obſerving the object with an azimuth-compaſs.

Azimuth-Compaſs, an inſtrument for finding either the magnetical azimuth or amplitude of an heavenly object.

The learned Dr Knight invented ſome time ſince a very accurate and uſeful ſea-compaſs, which is at preſent uſed in the navy, and will be deſcribed under the article COMPASS. This inſtrument, with the following contrivance added by the ingenious Mr Smeaton, anſwers the purpoſes of an azimuth and amplitude compaſs.

The cover of the wooden box being taken off, the compaſs is in a condition to be made uſe of in the binnacle, when the weather is moderate; but if the ſea runs high, as the inner box is hung very free upon its centre (the better to anſwer its other purpoſes), it will be neceſſary to ſlacken the milled nut, placed upon one of the axes that ſupport the ring, and to lighten the nut on the outſide that correſponds to it. By this means, the inner box and ring will be liſted up from the edges, upon which they reſt, when free; and the friction will be increaſed, and that to any degree neceſſary, to prevent the too great vibrations, which otherwiſe would be occaſioned by the motion of the ſhip.

To make the compaſs uſeful in taking the magnetic azimuth or amplitude of the ſun and ſtars, as alſo the bearings of headlands, ſhips, and other objects at a diſtance, the braſs edge deſigned at firſt to ſupport the card, and throw the weight thereof as near the circumference as poſſible, is itſelf divided into degrees and halves; which may be eaſily eſtimated into ſmaller parts, if neceſſary. The diviſions are determined by means of a catgut line, ſtretched perpendicularly with the box, as near the braſs edge as may be, that the parallax, ariſing from a different poſition of the obſerver, may be as little as poſſible.

Underneath the card are two ſmall weights, ſliding on two wires, placed at right angles to each other; which being moved nearer to, or farther from, the centre, counterbalance the dipping of the card in different latitudes, or reſtore the equilibrium of it, where it happens by any other means to be got too much out of level.

There is alſo added an index at the top of the inner box, which may be put on and taken off at pleaſure; and ſerves for all altitudes of the object. It conſiſts of a bar equal in length to the diameter of the inner box, each end being furniſhed with a perpendicular ſtile, with a ſlit parallel to the ſides thereof: one of the ſlits is narrow, to which the eye is applied; and the other is wider, with a ſmall catgut ſtretched up the middle of it, and from thence continued horizontally from the top of one ſtile to the top of the other. There is alſo

Azimuth. a line drawn along the upper ſurface of the bar. Theſe four, viz. the narrow ſlit, the horizontal catgut thread, the perpendicular one, and the line on the bar, are in the ſame plane, which diſpoſes itſelf perpendicular to the horizon, when the inner box is at reſt, and hangs free. This index does not move round, but is always placed on, ſo as to anſwer the ſame ſide of the box.

When the ſun's azimuth is deſired, and his rays are ſtrong enough to caſt a ſhadow, turn about the wooden box, till the ſhadow of the horizontal thread, or (if the ſun be too low) till that of the perpendicular thread, in one ſtile, or the light through the ſlit on the other, falls upon the line in the index bar, or vibrates to an equal diſtance on each ſide of it, gently touching the box, if it vibrates too far: obſerve, at the ſame time, the degree marked upon the braſs edge by the catgut line. In counting the degree for the azimuth, or any other angle that is reckoned from the meridian, make uſe of the outward circle of figures upon the braſs edge; and the ſituation of the index bar, with regard to the card and needle, will always direct upon what quarter of the compaſs the object is placed.

But if the ſun does not ſhine out ſufficiently ſtrong, place the eye behind the narrow ſlit in one of the ſtiles, and turn the wooden box about, till ſome part of the horizontal or perpendicular thread appears to interſect the centre of the ſun, or vibrate to an equal diſtance on each ſide of it, uſing ſmoked glaſs next the eye, if the ſun's light is too ſtrong. In this method, another obſerver will be generally neceſſary, to note the degree cut by the nonius, at the ſame time that the firſt gives notice that the thread appears to ſplit the object.

From what has been ſaid, the other obſervations will be eaſily performed; only, in caſe of the ſun's amplitude, take care to number the degree by the help of the inner circle of figures on the card, which are the complements of the outer to 90″; and, conſequently, ſhow the diſtance from eaſt to weſt.

The azimuth of the ſtars may alſo be obſerved by night; a proper light ſerving equally for one obſerver to ſee the thread, and the other the degree upon the card.

It may not be amiſs to remark farther, that, in caſe the inner box ſhould loſe its equilibrium, and, conſequently, the index be out of the plane of a vertical circle, an accurate obſervation may ſtill be made, provided the ſun's ſhadow is diſtinct; for, by obſerving firſt with one end of the index towards the ſun, and then the other, a mean of the two obſervations will be the truth.

Plate LXXVII. is a perſpective view of the compaſs, when in order for obſervation; the point of view being the centre of the card, and the diſtance of the eye two feet. A B is the wooden box. C and D are two milled nuts; by means whereof the axis of the inner box and ring are taken from their edges, on which they move, and the friction increaſed, when neceſſary. E F is the ring that ſupports the inner box. G H is the inner box; and I is one of its axes, by which it is ſuſpended on the ring E F. The magnet or needle appears paſſing through the centure, together with a ſmall brace of ivory, that confines the cap to its place. The card is a ſingle varniſhed paper, reaching as far as the outer circle of figures, which is a circle of thin braſs; the edge whereof is turned down at right angles to the plane of the card, to make it more ſtiff. O is a catgut line, drawn down the inſide of the box for determining the degree upon the braſs edge. P Q R S is the index bar, with its two ſtiles and catgut threads; which being taken off from the top of the box is placed in two peices, T and V, notched properly to receive it. W is a place cut out in the wood ſerving as an handle.

Azimuth || Azotus.

Azimuth Circles, called alſo *aximuths* or *vertical circles*, are great circles of the ſphere interſecting each other in the zenith and nadir, and cutting the horizon at right angles. Theſe azimuths are repreſented by the rhumbs on common ſea-charts, and on the globe they are repreſented by the quadrant of altitude, when ſcrewed in the zenith. On theſe azimuths is reckoned the height of the ſtars and the ſun when not in the meridian.

AZMER, a town of the Eaſt Indies in the dominions of the Great Mogul, capital of a province of the ſame name, with a very ſtrong caſtle. It is pretty large, and is ſometimes viſited by the Mogul himſelf. It is about 62 leagues diſtant from Agra. The principal trade of this province is in ſaltpetre.

AZOGA SHIPS, are thoſe Spaniſh ſhips commonly called the *quickſilver ſhips*, from their carrying quickſilver to the Spaniſh Weſt Indies, in order to extract the ſilver out of the mines of Mexico and Peru. Theſe ſhips, ſtrictly ſpeaking, are not to carry any goods unleſs for the king of Spain's account.

AZONI, in ancient mythology, a name applied by the Greeks to ſuch of the gods as were deities at large, not appropriated to the worſhip of any particular town or country; but acknowledged in general by all countries, and worſhipped by every nation. Theſe the Latins called *dii communes*. Of this ſort were the Sun, Mars, Luna, &c.

AZORES, iſlands in the Atlantic ocean, lying between 25 and 33 degrees of weſt longitude, and between 36 and 40 degrees of north latitude. They belong to the Portugueſe, and are alſo called the *weſtern iſles*, on account of their ſituation. They were diſcovered by the Flemings in the 15th century. They are ſeven in number, viz. Tercera, St Michael's, St Mary's, Gracioſa, St George's Iſland, Pico, and Fayal.

AZOTH, in ancient chemiſtry, the firſt matter of metals, or the mercury of a metal; more particularly that which they call the *mercury of philoſophers*, which they pretended to draw from all ſorts of metallic bodies.

AZOTUS, AZOTH, or ASHDOD, one of the five cities of the Philiſtines, and a celebrated ſea-port on the Mediterranean, ſituated about 14 or 15 miles ſouth of Ekron, between that and Aſcalon. It was in this city that the idol Dagon fell down before the ark; and ſo ſtrong a place it was, if we may believe Herodotus, that it ſuſtained a ſiege of 29 years by Pſammiticus king of Egypt. It was, however, taken by the Maccabees in a much ſhorter time; who burnt both city and temple, and with them about 8000 men. The town is now called by the Arabs *Haſaneyun*. It is but thinly inhabited, though the ſituation

Azure

tion is very pleaſant: with regard to the houſes, thoſe that were built in the time of Chriſtianity, and which are now inhabited by Mahometans, ſtill preſerve ſome claim to admiration; but the modern buildings, tho' generally of ſtone, have nothing in them which can attract the notice of a traveller. The ſtreets are pretty broad, the inhabitants moſtly Mahometans, with a few Chriſtians of the Greek communion, who have a church under the juriſdiction of the archbiſhop of Gaza. The town is about a mile and a half in circumference; and has in it a moſque, a public bath, a market-place, and two inns. The number of the inhabitants is between two and three thouſand. The moſt remarkable things in this place are an old ſtructure with fine marble pillars, which the inhabitants ſay was the houſe that Sampſon pulled down; and to the ſouth-eaſt, juſt out of the town, the water in which the eunuch of Candace was baptized by the apoſtle Philip: beſides theſe two, there are ſeveral ancient buildings, with capitals and pillars ſtanding.

AZURE, in a general ſenſe, the blue colour of the ſky. See SKY and BLUE.

AZURE, among painters. This word, which at preſent ſignifies in general a fine blue colour, was formerly appropriated to *Lapis Lazuli*, called *azure ſtone*, and to the blue prepared from it. But ſince a blue has been extracted from cobalt, cuſtom has applied to it the name of *azure*, although it differs conſiderably from the former, and is incapable of being uſed for the ſame purpoſes, and particularly for painting in oil. The former at preſent is called *lapis lazuli*; or only *lapis*; and the blue prepared from it for painting in oil, is called *ultramarine*.—The name *azure* is generally applied to the blue glaſs made from the earth of cobalt and vitrifiable matters. This glaſs, which is called *ſmalt* when in maſſes, is called *azure* only when it is reduced to a fine powder. Several kinds of azure are diſtinguiſhed, according to its degrees of beauty, by the names of *fine azure*, *powdered azure*, and *azure of four fires*. In general, the more intenſe the colour, and the finer the powder, the more beautiful and dear it is. Azure is employed to colour ſtarch; hence it has alſo been called *ſtarch-blue*. It is uſed for painting with colours, and for a blue enamel.

Azure | Azymous.

AZURE, in heraldry, the blue colours in the arms of any perſon below the rank of a baron. In the eſcutcheon of a nobleman, it is called *ſapphire*; and in that of a ſovereign prince, *Jupiter*. In engraving this colour is expreſſed by lines or ſtrokes drawn horizontally.—This colour may ſignify Juſtice, Perſeverance, and Vigilance; but according to G. Leigh, if it is compounded with

Or	it ſignifies	Chearfulneſs.
Arg.		Vigilance.
Gul.		Readineſs.
Ver.		Enterprize.
Pur.		Goodneſs.
Sab.		Mournfulneſs.

French Heralds, *M. Upton*, and his followers, rank this colour before gules.

AZYGOS, in anatomy, a vein riſing within the thorax, on the right ſide, having no fellow on the left; whence it is called *azygos*, or *vena ſine pari*.

AZYMITES, in church-hiſtory, Chriſtians who adminiſter the euchariſt with unleavened bread. The word is formed from the Greek, α priv. and ζυμη *ferment*.—This appellation is given to the Latin by the Greek church, becauſe the members of the former uſe fermented bread in the celebration of the euchariſt. They alſo call the Armenians and Maronites by the ſame name, and for the ſame reaſon.

AZYMOUS, ſomething unfermented, or made without leaven; as unleavened bread. Sea-biſket is of this kind; and therefore, according to Galen, leſs wholeſome than bread that has been fermented.

B.

B, THE ſecond letter of the Engliſh and moſt other alphabets. It is the firſt conſonant, and firſt mute, and in its pronunciation is ſuppoſed to reſemble the bleating of a ſheep; upon which account Pierius tells us in his hieroglyphics, that the Egyptians repreſented the ſound of this letter by the figure of that animal.

B is alſo one of thoſe letters which the eaſtern grammarians call *labial*, becauſe the principal organs employed in its pronounciation are the lips. It is pronounced by preſſing the whole length of them together, and forcing them open with a ſtrong breath. It has a near affinity with the other labials P and V, and is often uſed for P both by the Armenians and other orientals, as in *Betrus* for *Petrus*, *apſens* for *abſens*, &c.; and by the Romans for V, as in *amabit* for *amavit*, *berna* for *verna*, &c. whence aroſe that jeſt of Aurelian on the emperor Bonoſus, *Non ut vivat natus eſt, ſed ut bibat*.

Plutarch obſerves, that the Macedonians changed Φ into B, and pronounced *Bilip*, *Berenice*, &c. for *Philip*, *Pherenice*, &c.; and thoſe of Delphos uſed B inſtead of Π, as βαβιν for παθειν, βικρον for πικρον, &c.—The Latins ſaid *ſuppono*, *oppono*, for *ſubpono*, *obpono*; and pronounced *optinuit*, though they wrote *obtinuit*, as Quintilian has obſerved.—They alſo uſed B for F or PH: thus, in an ancient inſcription mentioned by Gruter, OBRENDARIO is uſed for OFRENDARIO.

As a numeral, B was uſed by the Greeks and Hebrews to denote 2; but among the Romans for 300, and with a daſh over it (thus $\overline{B}$) for 3000.

Baal. B is alſo uſed as an abbreviation. Thus B. A. ſtands for bachelor of arts; B. L. for Bachelor of laws; and B. D. for bachelor of divinity. B. F. in the preface to the decrees or ſenatus-conſulta of the old Romans ſignified *bonum factum*. In muſic, B ſtands for the tone above A; as B♭, or ♭B, does for B flat, or the ſemitone major above A. B alſo ſtands for baſs; and B. C. for *baſſo continuo*, or thorough baſs.

BAAL, the ſame as BEL, or BELUS; an idol of the Chaldeans and Phœnicians, or Canaanites. The former worſhipped Mars under this name, according to Joſephus*; who, ſpeaking of Thurus the ſucceſſor of Ninus ſays, "To this Mars the Aſſyrian erected the firſt ſtatue, and worſhipped him as a god, calling him *Baal*." It is probable the Phœnicians worſhipped the ſun under the name of Baal; for Joſiah, willing to make ſome amends for the wickedneſs of Manaſſeh, in worſhipping Baal and all the hoſt of heaven, *put to death the idolatrous prieſts that burnt incenſe unto Baal, to the ſun, and to the moon, and to the planets, and to all the hoſt of heaven. He likewiſe took away the horſes that the kings of Judah had given to the ſun, and burnt the chariots of the ſun with fire* †.

* *Antiquit.* lib. viii. cap. 7.

† 2 Kings xxiii. 5. 11.

The temples conſecrated to this god, are called in the Scripture *Chamanim*, which ſignifies *places incloſed with walls*, in which was kept a perpetual fire. Maundrell, in his journey from Aleppo to Jeruſalem, obſerved ſome traces of theſe incloſures in Syria. In moſt of them were no ſtatues; in a few there were ſome, but of no uniform figure.

The word *baal* (in the Punic language), ſignifies *lord* or *maſter*; and doubtleſs meant the ſupreme Deity, the Lord and Maſter of the univerſe. It is often joined with the name of ſome falſe god, as *Baal-berith*, *Baal-peor*, *Baal-zephon*, and the like. This deity paſſed from the Phœnicians to the Carthaginians, who were a colony of the Phœnicians; as appears from the Carthaginian names, Hannibal, Aſdrubal, &c. according to the cuſtom of the eaſt, where kings and great men added to their own names thoſe of their gods.

This falſe deity is frequently mentioned in Scripture in the plural number (*Baalim*): which may ſignify, either that the name *Baal* was given to ſeveral different gods; or that there were many ſtatues, bearing different appellations, conſecrated to this idol. Arnobius tells us, that Baal was of an uncertain ſex; and that his votaries, when they called upon him, invoked him thus: *Hear us, whether thou art a god or a goddeſs.*

Some learned men think, that the Baal of the Phœnicians is the Saturn of the Greeks; which is probable enough from the conformity there is between the human ſacrifices offered to Saturn and thoſe which the Scripture tells us were offered to Baal. Others are of opinion, that Baal was the Phœnician or Tyrian Hercules, a god of great antiquity in Phœnicia.

BAAL-BERITH, the god of the Shechemites. Bochart conjectures, that Berith is the ſame as *Beroe*, the daughter of Venus and Adonis, who was given in marriage to Bacchus; and that ſhe gave her name to the city of Berith in Phœnicia, and became afterwards the goddeſs of it. Baal-berith ſignifies *Lord of the Covenant*, and may be taken for the god that preſides over alliances and oaths, in like manner as the Greeks had their Ζευς ορκιος, and the Romans their *Deus Fidius*, or *Jupiter Piſtius*. The idolatrous Iſraelites, we are told, *made Baal-berith their god*, Judg. viii. 33.

Baal ‖ Babel.

BAAL-PEOR, *Baal-phegor*, or *Beel-phegor*, an idol of the Moabites and Midianites. We are told, that *Iſrael joined himſelf to Baal-peor*; and that Solomon erected an altar to this idol upon the mount of Olives. Baal-peor has been ſuppoſed to be no other than a Priapus, and that the worſhip of him conſiſted in the moſt obſcene practices. Others have thought, that, as Baal is a general name ſignifying *Lord*, Peor may be the name of ſome great prince deified after his death. Mede imagines, that, *Peor* being the name of a mountain in the country of Moab, on which the temple of Baal was built, Baal-peor may be only another name of that deity, taken from the ſituation of his temple; in like manner as Jupiter is ſtyled *Olympius*, becauſe he was worſhipped in a temple built on mount Olympus. Selden, who is of this latter opinion, conjectures likewiſe, that Baal-peor is the ſame with Pluto; which he grounds upon theſe words of the Pſalmiſt*, *They joined themſelves unto Baal-peor, and eat the offerings of the dead*; though by the *ſacrifices* or *offerings of the dead*, in this paſſage, may be meant no more than ſacrifices or offerings made to idols, or falſe gods, who are very properly called *the dead*, in contradiſtinction to the true God, who is ſtyled in Scripture the *living God*.

* Pſalm cvi.

BAAL-ZEBUB, *Beel-zebub*, or *Belzebub*; the idol, or god, of the Ekronites. In Scripture he is called the *Prince of Devils*. His name is rendered the *Lord of Flies*, or the *God-fly*; which ſome think was a mock appellation beſtowed on him by the Jews. He had a famous temple and oracle at Ekron. Ahaziah king of Iſrael, having fallen from the terraſs of his houſe into a lower room, and being dangerouſly hurt, ſent to conſult this deity, to know if he ſhould be cured of his wounds. The worſhip of this falſe god muſt have prevailed in our Saviour's time, ſince the Jews accuſed him of driving out devils in the name of *Belzebub* their prince. Scaliger derives the name of this deity from *Baalim-zebahim*, which ſignifies the *Lord of ſacrifices*.

BABBLING, among hunters, is when the hounds are too buſy after they had found a good ſcent.

BABEL, a city and tower undertaken to be built by the whole human race ſoon after the flood, and remarkable for the miraculous fruſtration of the attempt by the confuſion of languages. As to the ſituation of ancient Babel, moſt authors are of opinion that it was, exactly in the place where the celebrated city of Babylon afterwards ſtood. That it was in the ſame country, appears indiſputably from Scripture; but that it was exactly in the ſame place is what cannot be proved, nor is it a matter of any conſequence.

Authors have been much divided about the motive by which the whole race of mankind were induced to join as one man in ſuch an undertaking. Some have imagined that it was out of fear of a ſecond deluge; others, that they knew beforehand that they were to be diſperſed through all the different countries of the world, and built this tower in order to defeat the deſign of the Deity, becauſe having a tower of ſuch vaſt height as they propoſed, thoſe who were at a diſtance could eaſily find their way back again. Had either of theſe been their deſign, however, it is probable they would have choſen an eminence rather than a plain for the

Babel. the ſituation of their tower, or indeed that they would have choſen ſome high mountain ſuch as Ararat for their mark, rather than any tower at all: for though it is ſaid that they deſigned the top of their tower to reach to heaven, we can ſcarce ſuppoſe them to have been ſo abſurd, as to imagine this poſſible in the ſenſe we underſtand it; and muſt therefore rather take it in the limited ſenſe in which it is often uſed by Moſes and his countrymen, where they ſpeak of cities walled up to heaven. Others there are who imagine that the top of this tower was not to reach up to heaven, but to be conſecrated to the heavens, *i. e.* to the worſhip of the ſun, moon, and ſtars; of the fire, air, &c. and other natural powers as deities; and therefore that the true Deity interpoſed in order to prevent a total and irrecoverable defection. Certain it is, that the ſpecies of idolatry which takes for the objects of its worſhip thoſe natural agents, as it is the moſt ancient, ſo it is by far the moſt rational, and the moſt difficult to be diſproved. It is much more difficult, for inſtance, to prove that the ſun, which by his enlivening beams gives vigour to the whole creation, is not a deity, than that a log of wood is not one; and hence, if ſuch a ſyſtem of religion became univerſally eſtabliſhed among mankind, it would be impoſſible ever afterwards to eradicate it. Indeed that the ſcheme of Babel, whatever it was, could have been put in execution by man, ſeems evident from the interpoſition of the Deity on the occaſion; for we cannot ſuppoſe that he would have worked a miracle on purpoſe to defeat that which would have defeated itſelf if he had let it alone: and he expreſsly ſays, That now nothing could be reſtrained from them; which intimates very plainly, that, had this ſcheme gone on, the plan which God had laid for the government of the world would have been totally fruſtrated: and agreeable to this hypotheſis Dr Tenniſon ſuppoſes that the tower was of a pyramidal form, in imitation of the ſpires of flame; and that it was erected in honour of the ſun, as being the moſt probable cauſe of drying up the flood.

As to the materials made uſe of in the building of this tower, the Scripture informs us that they were bricks and ſlime or bitumen. According to an eaſtern tradition, three years were taken up in making the bricks, each of which was 13 cubits long, 10 broad, and five thick. Oriental writers ſay, that the city was 313 furlongs in length, and 151 in breadth; that the walls were 5533 fathoms high, and 33 in breadth; and that the tower itſelf was no leſs than 10,000 fathom, or 12 miles high. Even St Jerome affirms from the teſtimony of eye-witneſſes, who as he ſays had examined the remains of the tower, that it was four miles high; but Ado makes the height to have been no leſs than 5000 miles. The only account of its dimenſions which can be at all depended upon (ſuppoſing it to have been the ſame which afterwards ſtood in the midſt of the city of Babylon, and round which Nebuchadnezzar built the temple of Belus), is that given under the article BABYLON.

BABEL-MANDEL, the GATE OF MOURNING; a famous ſtrait in the Indian ocean, between the coaſt of Arabia Felix in Aſia, and that of Adel and Zeila in Africa, at the entrance into the Red Sea. By ſome it is alſo called the *Straits of Moka*. It is narrow, and difficult to ſail through, on account of the ſand-banks. At the mouth of the ſtrait is a ſmall iſland called alſo *Babel-Mandel*, which is little elſe than a barren rock. E. Long. 44. 30. N. Lat. 12. 40.

Babenhauſen ‖ Babington.

BABENHAUSEN, a town of Germany in Suabia. E. Long. 9. 16. N. Lat. 48. 39.

BABINA (*Commonwealth* of), a ſociety ludicrouſly ſo called, which was founded in Poland in the reign of Sigiſmund-Auguſtus, in the 16th century. It took its riſe from a ſet of gentlemen, inhabitants of Lublin, who had agreed to meet at a place called *Babina*, merely for the purpoſes of mirth and jollity. In time their number increaſed, and they formed themſelves into a regular government, under the preſidency of a king, ſenate, and chief magiſtrates. The magiſtrates were elected from ſomething which appeared ridiculous in the character or conduct of any of the members. For inſtance, if any perſon was meddling or officious, he was immediately created an archbiſhop; a blundering or diſputatious member was promoted to the ſpeaker's chair; a boaſter of his own courage, and vainglorious *Thraſo*, was honoured with the commiſſion of generaliſſimo, which was preſented him with great ceremony by the ſubordinate heroes. Thoſe who declined the office for which they were declared qualified, were perſecuted with hiſſings, and abandoned by the ſociety. Thus every vice and every foible was attacked with ridicule; and Babina became in a ſhort time the terror, the admiration, and the reformer, of the Poliſh nation: genius flouriſhed, wit was cultivated, and the abuſes which had crept into government and ſociety were corrected by the judicious application of good-humoured ſatire. Never did any inſtitution of this nature become ſo general or ſo uſeful; but at length it degenerated into a ſeat of buffoons, and banterers of every thing ſacred or profane. For ſeveral years it was patroniſed by the kings of Poland, and Sigiſmund himſelf became a member; the ſtaroſta of Babina telling him jocularly, That "His majeſty had certain qualities which intitled him to the firſt dignity in the commonwealth." Not the leaſt remnant of this ſociety now remains, though it was honoured with extraordinary privileges by kings and emperors.

BABINGTON (Gervaſe), biſhop of Worceſter, was born, according to Fuller, in Nottinghamſhire; but in what year is uncertain. He was ſent to Trinity College, Cambridge, of which he was made fellow; and, in 1578, was incorporated maſter of arts at Oxford. He appears, however, to have made Cambridge the place of his reſidence, where he became an eminent preacher; and, being now doctor of divinity, was made domeſtic chaplain to Henry Earl of Pembroke. In this ſtation he is ſuppoſed to have aſſiſted the counteſs in her tranſlation of the Pſalms. In 1588 he was inſtalled prebend of Hereford, and in 1591 conſecrated biſhop of Landaff. In 1594 he was tranſlated to the ſee of Exeter, and thence to Worceſter in 1597. About this time, or ſoon after, he was made queen's counſel for the marſhes of Wales. He was a conſiderable benefactor to the library belonging to the cathedral of Worceſter, where he was buried in May 1610 without a monument. The ſeveral hiſtorians who have mentioned this prelate agree in giving him the character of a learned and pious man. His writings, like thoſe of moſt of his cotemporaries, abound with puns and quaint expreſſions. His works were printed both

Baboon, Babylon.

in folio and quarto in 1615, and again in folio in 1637, under this title; *The works of the right reverend father in God Gervaſe Babington, late biſhop of Worceſter, containing comfortable notes upon the five books of Moſes*, viz. *Geneſis, &c. As alſo an expoſition upon the Creed, the Ten Commandments, the Lord's Prayer; with a conference betwixt man's frailtie and faith, and three ſermons, &c.*

BABOON, in zoology. See SIMIA.

BABYLON, the capital of the ancient kingdom of Babylonia or Chaldæa, and ſuppoſed to have ſtood in E. Long. 44. 0. N. Lat. 32. 0. Semiramus is ſaid by ſome, and Belus by others, to have founded this city. But, by whomſoever it was founded, Nebuchadnezzar was the perſon who put the laſt hand to it, and made it one of the wonders of the world. The moſt famous works in and about it were the walls of the city, the temple of Belus, Nebuchadnezzar's palace, the hanging-gardens, the banks of the river, the artificial lake, and canals.

1 City deſcribed.

The city was ſurrounded with walls, in thickneſs 87 feet, in height 350 feet, and in compaſs 480 furlongs or 60 of our miles. Thus Herodotus, who was himſelf at Babylon; and though ſome diſagree with him in theſe dimenſions, yet moſt writers give us the ſame, or near the ſame, as he does. Diodorus Siculus diminiſhes the circumference of theſe walls very conſiderably, and takes ſomewhat from the height of them, as in Herodotus; tho' he ſeems to add to their breadth, by ſaying, that ſix chariots might drive abreaſt thereon; while the former writes, that one chariot only might turn upon them; but then he places buildings on each ſide of the top of theſe walls, which, according to him, were but one ſtory high; which may pretty well reconcile them together in this reſpect. It is obſerved, that thoſe who give the height of theſe walls but at 50 cubits, ſpeak of them only as they were after the time of Darius Hyſtaſpis, who had cauſed them to be beaten down to that level. Theſe walls formed an exact ſquare, each ſide of which was 120 furlongs, or 15 miles, in length; and were all built of large bricks cemented together with bitumen, which in a ſhort time grows harder than the very brick and ſtone which it cements. The city was encompaſſed, without the walls, with a vaſt ditch filled with water, and lined with bricks on both ſides; and, as the earth that was dug out of it ſerved to make the bricks, we may judge of the depth and largeneſs of the ditch from the height and thickneſs of the walls. In the whole compaſs of the wall there were 100 gates, that is, 25 on each of the four ſides, all made of ſolid braſs. Between every two of theſe gates, at proper diſtances, were three towers, and four more at the four corners of this great ſquare, and three between each of theſe corners and the next gate on either ſide, and each of theſe towers was ten feet higher than the walls. But this is to be underſtood only of thoſe parts of the walls where towers were needful for defence. For ſome parts of them being upon a moraſs, and inacceſſible by an enemy, there the labour and coſt was ſpared, which tho' it muſt have ſpoiled the ſymmetry of the whole, muſt be allowed to have favoured of good œconomy; though that is what one would not have expected from a prince who had been ſo determined, as Nebuchadnezzar muſt have been, to make the city complete both for ſtrength and beauty. The whole number, then, of theſe towers amounted to no more than 250; whereas a much greater number would have been neceſſary to have made the uniformity complete all round. From the 25 gates on each ſide of this ſquare, there was a ſtraight ſtreet, extending to the correſponding gate in the oppoſite wall; whence the whole number of the ſtreets muſt have been but 50; but then they were each about 15 miles long, 25 of them croſſing the other 25 exactly at right angles. Beſides theſe whole ſtreets, we muſt reckon four half-ſtreets, which were but rows of houſes facing the four inner ſides of the walls. Theſe four half-ſtreets were properly the four ſides of the city within the walls, and were each of them 200 feet broad, the whole ſtreets being about 150 of the ſame. By this interſection of the 50 ſtreets, the city was divided into 676 ſquares, each of four furlongs and a half on each ſide, or two miles and a quarter in compaſs. Round theſe ſquares on every ſide towards the ſtreets ſtood the houſes, all of three or four ſtories in height, and beautified with all manner of ornaments; and the ſpace within each of theſe ſquares was all void, and taken up by yards, or gardens, and the like, either for pleaſure or convenience. Babylon.

A branch of the Euphrates divided the city into two, running through the midſt of it, from north to ſouth; over which, in the very middle of the city, was a bridge, a furlong in length, or rather more, and indeed much more, if we hearken to others, who ſay it was no leſs than five ſtades or furlongs in length, tho' but 30 feet broad, a difference we ſhall never be able to decide. This bridge, however, is ſaid to have been built with wonderful art, to ſupply a defect in the bottom of the river, which was all ſandy. At each end of this bridge were two palaces; the old palace on the eaſt ſide, the new one on the weſt ſide of the river; the former of which took up four of the ſquares abovementioned, and the latter nine. The temple of Belus, which ſtood next to the old palace, took up another of the ſame ſquares.

The whole city ſtood in a large flat or plain, in a very fat and deep ſoil: that part or half of it on the eaſt ſide of the river was the old city, and, the other on the weſt was added by Nebuchadnezzar, both being included within the vaſt ſquare bounded by the walls aforeſaid. The form of the whole was ſeemingly borrowed from Nineveh, which was alſo 480 furlongs; but though it was equal in dimenſions to this city, it was leſs with reſpect to its form, which was a parallellogram, whereas that of Babylon was an exact ſquare. It is ſuppoſed, that Nebuchadnezzar, who had deſtroyed that old ſeat of the Aſſyrian empire, propoſed that this new one ſhould rather exceed it; and that it was in order to fill it with inhabitants, that he tranſported ſuch numbers of the captives from other countries hither; though that is what may be diſputed, ſeeing he therein only followed the conſtant practice of the kings of Aſſyria, who thought this the moſt certain means of aſſuring their conqueſts either to themſelves or their poſterity.

2 Was never fully peopled.

But it plainly appears, that it was never wholly inhabited; ſo that, even in the meridian of its glory, it may be compared with the flower of the field, which flouriſhes to-day, and to-morrow is no more. It never had time to grow up to what Nebuchadnezzar viſibly intended to have made it; for, Cyrus removing the

Babylon. the ſeat of the empire ſoon after to Shuſhan, Babylon fell by degrees to utter decay; yet it muſt be owned, that no country was better able to ſupport ſo vaſt and populous a city, had it been completed up to its firſt deſign. But ſo far was it from being finiſhed according to its original deſign, that, when Alexander came to Babylon, Q. Curtius tells us, "No "more than 90 furlongs of it were then built:" which can be no otherwiſe underſtood, than of ſo much in length; and, if we allow the breadth to be as much as the length (which is the utmoſt that can be allowed), it will follow, that no more than 8100 ſquare furlongs were then built upon: but the whole ſpace within the walls contained 14,400 ſquare furlongs; and therefore there muſt have been 6300 ſquare furlongs remaining unbuilt, which, Curtius tells us, were plowed and ſown. And, beſides this, the houſes were not contiguous, but all built with a void ſpace on each ſide, between houſe and houſe.

3 Temple of Belus. The next great work of Nebuchadnezzar was the temple of Belus. The wonderful tower, however, that ſtood in the middle of it, was not his work, but was built many ages before; that, and the famous tower of Babel, being as is commonly ſuppoſed, one and the ſame ſtructure. This tower is ſaid to have been compoſed of eight pyramidal ones raiſed above one another, and by Herodotus ſaid to have been a furlong in height, but as there is an ambiguity in his expreſſion, it has been diſputed whether each of the towers was a furlong in height, or the whole of them taken together. On the latter ſuppoſition, which is the moſt probable, this tower muſt have exceeded the higheſt of the Egyptian pyramids by 179 feet, though it fell ſhort of its breadth at the baſis by 33. The way to go up was by ſtairs on the outſide round it; whence it ſeems moſt likely, that the whole aſcent was, by the benching in, drawn in a ſloping line from the bottom to the top eight times round it; and that this made the appearance of eight towers, one above the other. Till the times of Nebuchadnezzar, it is thought that this tower was all the temple of Belus; but as he did by the other ancient buildings of the city, ſo he did by this, making great additions thereto, by vaſt edifices erected round it, in a ſquare of two furlongs on every ſide, and juſt a mile in circumference, which exceeded the ſquare at the temple of Jeruſalem by 1800 feet. On the outſide of theſe buildings was a wall, which incloſed the whole; and, in conſideration of the regularity wherewith this city was to all appearance marked out, it is ſuppoſed that this wall was equal to the ſquare of the city wherein it ſtood, and ſo is concluded to have been two miles and an half in circumference. In this wall were ſeveral gates leading into the temple, and all of ſolid braſs; which it is thought may have been made out of the braſen ſea, and braſen pillars, and other veſſels and ornaments of the kind, which Nebuchadnezzar had tranſported from Jeruſalem; for in this temple he is ſaid to have dedicated his ſpoils from that of Jeruſalem.

4 Idols of gold, &c. In this temple were ſeveral images or idols of maſſy gold, and one of them, as we have ſeen 40 feet in height; the ſame, as ſuppoſed, with that which Nebuchadnezzar conſecrated in the plains of Dura. For though this laſt is ſaid to have been 60 cubits, or 90 feet high, theſe dimenſions appear ſo incredible, that it has been attempted to reconcile them into one, by ſuppoſing that in the 90 feet the height of the pedeſtal is included, and that the 40 feet are for the height of the ſtatue without the pedeſtal; and, being ſaid to have weighed 1000 talents of Babylon, it is thence computed, that it was worth three millions and an half of our money. In a word, the whole weight of the ſtatues and decorations, in Diodorus Siculus, amounting to 5000 and odd talents in gold, the whole is eſtimated at above one and twenty millions of our money; and a ſum about equal to the ſame, in treaſure, utenſils, and ornaments, not mentioned is allowed, for. Babylon.

Next to this temple, on the eaſt ſide of the river, ſtood the old palace of the kings of Babylon, being four miles in circumference. Exactly oppoſite to it, on the other ſide of the river, was the new palace built by Nebuchadnezzar, eight miles in cirumference, and conſequently four times as big as the old one.

5 Hanging gardens. But nothing was more wonderful at Babylon than the hanging gardens, which Nebuchadnezzar made in complaiſance to his wife Amyte; who, being a Mede, and retaining a ſtrong inclination for the mountains and foreſts of her own country, was deſirous of having ſomething like them at Babylon. They are ſaid to have contained a ſquare of four plethra, or 400 feet, on each ſide; and to have conſiſted of terraces one above another, carried up to the height of the wall of the city, the aſcent from terrace to terrace being by ſteps ten feet wide. The whole pile conſiſted of ſubſtantial arches upon arches, and was ſtrengthened by a wall ſurrounding it on every ſide, 22 feet thick; and the floors on each of them were laid in this order: firſt, on the tops of the arches was laid a bed or pavement of ſtones 16 feet long, and four feet broad; over this was a layer of reed mixed with a great quantity of bitumen; and over this two courſes of brick, cloſely cemented together with plaſter; and over all theſe were thick ſheets of lead, and on theſe the earth or mould of the garden. This floorage was deſigned to retain the moiſture of the mould; which was ſo deep, as to give root to the greateſt trees which were planted upon every terrace, together with great variety of other vegetables pleaſing to the eye. Upon the uppermoſt of theſe terraces was a reſervoir, ſupplied by a certain engine with water from the river, from whence the gardens on the other terraces were ſupplied.

6 Banks of the river, canals, &c. The other works attributed to Nebuchadnezzar by Beroſus and Abydenus, were the banks of the river, the artificial canals, and the great artificial lake ſaid to have been ſunk by Semiramis. The canals were cut out on the eaſt ſide of the Euphrates, to convey the waters of that river, when it overflowed its banks, into the Tigris, before they reached Babylon. The lake was on the weſt ſide of Babylon; and, according to the loweſt computation, 40 miles ſquare, 160 in compaſs, and in depth 35 feet, as we read in Herodotus, or 75, as Megaſthenes will have it; the former, perhaps, meaſured from the ſurface of the ſides, and the latter from the tops of the banks that were caſt up upon them. This lake was dug to receive the waters of the river, while the banks were building on each ſide of it. But both the lake, and the canal which led to it, were preſerved after that work was completed, being found of great uſe, not only to pre-

Babylon. vent all overflowings, but to keep water all the year, as in a common reſervoir, to be let out on proper occaſions, by ſluices, for the improvement of the land.

The banks were built of brick and bitumen, on both ſides of the river, to keep it within its channel; and extended on each ſide throughout the whole length of the city, and even farther, according to ſome, who reckon they extended 160 furlongs, or twenty miles; whence it is concluded they muſt have begun two miles and an half above the city, and have been continued an equal diſtance below it, the length of the city being no more than 15 miles. Within the city they were built from the bottom of the river, and of the ſame thickneſs with the walls of the city itſelf. Oppoſite to each ſtreet, on either ſide of the river, was a brazen gate in the ſaid wall, with ſtairs leading down from it to the river: theſe gates were open by day, and ſhut by night.

Beroſus, Megaſthenes, and Abydenus, attribute all theſe works to Nebuchadnezzar; but Herodotus tells us, the bridge, the banks, and the lake, were the work of a queen after him, called *Nitocris*, who may have finiſhed what Nebuchadnezzar left imperfect, and thence have had the honour this hiſtorian gives her of the whole.

The tower or temple ſtood till the time of Xerxes. But that prince on his return from the Grecian expedition, having firſt plundered it of its immenſe wealth, demoliſhed the whole, and laid it in ruins. Alexander, on his return to Babylon from his Indian expedition, propoſed to rebuild it, and accordingly ſet 10,000 men on work to clear away the rubbiſh. But his death happening ſoon after, a ſtop was put to all further proceedings in that deſign. After the death of that conqueror, the city of Babylon began to decline apace; which was chiefly owing to the neighbourhood of Seleucia, built by Seleucus Nicator, as is ſaid, out of ſpite to the Babylonians, and peopled with 500,000 perſons drawn from Babylon, which by that means continued declining till the very people of the country were at a loſs to tell where it had ſtood.

Such is the deſcription we have by ancient hiſtorians of the grandeur of this city; which, if theſe accounts are not exaggerated, muſt have exceeded every piece of human grandeur that hath yet appeared. Many of the moderns, however, are of opinion that theſe magnificent deſcriptions are very far from being true; although it is certain that few other arguments can be brought againſt the reality of them, than that we do not ſee things of a ſimilar kind executed in our own days. The following are the arguments uſed on this ſubject by the preſident Goguet.

7 Goguet's arguments againſt the truth of the foregoing relation.

"Authors have greatly extolled the public works and edifices which once rendered Babylon one of the wonders of the world. We may reduce all theſe objects to five principal heads; 1. The height of its walls; 2. the temple of Belus; 3. the hanging gardens; 4. the bridge built over the river Euphrates, and the quays which lined that river; 5. the lake and canals dug by the hands of man to diſtribute the waters of the Euphrates.

"All theſe works ſo marvellous in the judgment of antiquity, appear to me to have been extremely exaggerated by the authors who have ſpoken of them. How can we conceive, in effect, that the walls of Babylon could have been 318 feet high, and 81 in thickneſs, in a compaſs of near ten leagues? Babylon.

"I ſhall ſay the ſame of that ſquare building, known under the name of *the temple of Belus*. It was compoſed of eight towers placed one above another, diminiſhing always as they went up. Herodotus does not tell us what was the height of this monument. Diodorus ſays, that it ſurpaſſed all belief. Strabo fixes it at one ſtadium, a meaſure which anſwers nearly to 600 of our feet. For in the time of this geographer the ſtadia were much more conſiderable than in the firſt ages. The entire maſs of this building ought to have been anſwerable its exceſſive height; and this is alſo the idea that the ancients deſigned to give us of it. We may judge by the following fact. Xerxes had entirely demoliſhed this temple. Alexander undertook to rebuild it. He deſigned to begin by clearing the place and removing the ruins. Ten thouſand workmen who were employed two months in this work, were not, ſay they, able to finiſh it.

"The riches incloſed in the temple of Belus were proportioned to its immenſity. Without ſpeaking of the tables and cenſers, the cups, and other ſacred vaſes, of maſſy gold, there was a ſtatue 40 feet high, which alone weighed 1000 Babyloniſh talents. In ſhort, according to the inventory that the ancients have given us of the riches contained in this temple, the total ſum would amount to two hundred and twenty millions and a half of French livres. Exaggerations like theſe deſtroy themſelves.

"As to the hanging gardens, according to all appearance they never exiſted. The ſilence of Herodotus on a work ſo ſingular and ſo remarkable, determines me to place in the rank of fables all that the other writers have delivered upon this pretended wonder. Herodotus had carefully viſited Babylon. He enters into ſuch details as prove that he has omitted none of the rarities of that city. Can we preſume that he would have paſſed over in ſilence ſuch a work as the hanging gardens? All the authors who have ſpoken of it are of much later date than this great hiſtorian. None of them except Beroſus ſpeaks on his own teſtimony. It is always on the report of others. Diodorus had extracted from Cteſias what he ſays of theſe famous gardens. There is alſo great appearance that Strabo had drawn from the ſame ſource. In a word, the manner in which Quintus Curtius expreſſes himſelf, ſufficiently ſhows how much the exiſtence of theſe gardens appeared to him ſuſpicious. He judged they owed the greateſt part of it to the imagination of the Greeks.

"Let us now ſpeak of the bridge of Babylon, which the ancients have placed in the number of the moſt marvellous works of the eaſt. It was near 100 fathoms in length, and almoſt four in breadth. We cannot deny but that a great deal of art and labour was neceſſary to lay the foundations, which it could not be eaſy to ſettle in the bed of an extremely deep and rapid river, which alſo rolls along a prodigious quantity of mud, and whoſe bottom is entirely ſandy. They had therefore taken many precautions to ſecure the piers of the bridge of Babylon. They were built of ſtones joined and faſtened together with cramps of iron, and their joints filled with melted lead. The front of the piers, turned towards the current of the Euphrates,

Babylon, Babylonia.

was defended by buttreſſes extremely advanced, which diminiſhed the weight and force of the water, by cutting it at a great diſtance. Such was the bridge of Babylon.

"While we do juſtice to the ſkill of the Babylonians in conducting theſe works, we cannot help remarking the bad taſte which at all times reigned in the works of the eaſtern nations. The bridge of Babylon furniſhes a ſtriking inſtance of it. This edifice was abſolutely without grace, or any air of majeſty. The breadth of it was in no ſort of proportion to its length. The diſtance between the piers was alſo very ill contrived. They were diſtant from each other only 11 feet and a half. Finally, this bridge was not arched. We may judge of its effect on the view.

"The Babylonians, however, were not the only people who were ignorant of the art of turning an arch. This ſecret, as far as I can find, was unknown to all the people of remote antiquity, who, generally ſpeaking, do not appear to have been very ſkilful in ſtone-cutting.

"As for the quays which lined the Euphrates, we may believe that they were grand and magnificent: but I ſhall not eaſily believe that they ſurpaſſed thoſe which we have daily under our eyes. In this reſpect, I believe Paris may diſpute it for magnificence, and for the extent of the work, with all the cities of the univerſe."

Babylon, a town of Egypt near the eaſtmoſt branch of the river Nile, now ſuppoſed to be *Grand Cairo*, or this city to ſtand near its ruins. E. Long. 31. 12. N. Lat. 30. 5.

BABYLONIA, or Chaldæa, a kingdom of Aſia and the moſt ancient in the world, being founded by Nimrod the grandſon of Ham, who alſo, according to the margin of our Bibles, founded Nineveh the capital of the kingdom of Aſſyria. Indeed, theſe two kingdoms ſeem to have always continued in ſuch a ſtate of friendſhip, that we can ſcarce help thinking they muſt have been the ſame, or perhaps Babylonia was for ſome time a province of Aſſyria. Nothing certain is known concerning either of them, except what may be gathered from Scripture. From thence we learn, that in the days Abraham there was a king of *Shinar*, called *Amraphel*, who, under the king of Elam or Perſia made war upon the Canaanites. From this time we have nothing that can be depended upon till the days of Nabonaſſar, the firſt king of Babylon mentioned in Ptolemy's canon. It is plain indeed, both from Scripture and profane hiſtory, that Babylonia ſubſiſted as a diſtinct kingdom from Aſſyria even when the latter was in all its glory. The moſt probable account of the matter is this: The empire of Aſſyria was founded by Pul, on the ruins of that of Damaſcus or Syria, in the days of Menahem king of Judah. This king left two ſons, Tiglath-Pileſer, and Nabonaſſer. To the former he bequeathed the empire of Aſſyria, and to the latter that of Babylon. Tiglath-Pileſer reſided at Nineveh, the original ſeat of the Aſſyrian empire; while Nabonaſſer, who was the younger brother, held his reſidence at Babylon. As the two kingdoms were governed by princes of the ſame family, we may well ſuppoſe a perfect harmony to have reigned between them, the younger branch at Babylon acknowledging a kind of ſubjection to the elder at Nineveh. That the Babylonian empire was of Aſſyrian origin, we are aſſured by the prophet Iſaiah, in the following words: "Behold the land of the Chaldeans: this people was not till the Aſſyrian founded it for them that dwelt in the wilderneſs; they ſet up the towers thereof: they built the palace thereof." As to the kingdom of Aſſyria, the Scripture mentions only five kings, *viz.* Pul, Tiglath-Pileſer, Shalmanaſer, Sennacharib, and Eſarhaddon; whoſe hiſtory, as related by the ſacred writers, it is needleſs to mention particularly here. From the days of Nabonaſſer, to Nabopolaſſer, that is, from the year before Chriſt 747 to 626, the kings of Babylon made no figure, and were therefore probably in a ſtate of dependence on the kings of Aſſyria; but at that time, in the reign of *Chyniladan*, the Sardanapalus of the Greeks, Nineveh was taken and deſtroyed by the Medes and Babylonians, and the ſeat of the empire transferred to Babylon. This Nabopolaſſer was the father of the famous Nebuchadnezzar, for whoſe hiſtory we muſt refer to the ſacred writers: and from his time to that of the *Belſhazzar* of Daniel, and *Nabonadius* of other authors, the hiſtory of Babylon is little better than a mere blank. Of the reduction of Babylon by Cyrus, which happened at this time, we have the following account. Babylonia.

War had been begun betwixt the Medes, Perſians, and Babylonians, in the reign of Nerigliſſar the father of Nabonadius, which had been carried on with very bad ſucceſs on the ſide of the Babylonians. Cyrus, who commanded the Median and Perſian army, having ſubdued the ſeveral nations inhabiting the great continent from the Ægean ſea to the Euphrates, bent his march towards Babylon. Nabonadius, hearing of his march, immediately advanced againſt him with an army. In the engagement which enſued, the Babylonians were defeated; and the king, retreating to his metropolis, was blocked up and cloſely beſieged by Cyrus. The reduction of this city was no eaſy enterpriſe. The walls were of a prodigious height, the number of men to defend them very great, and the place ſtored with all ſorts of proviſions for 20 years. Cyrus, deſpairing of being able to take ſuch a city by ſtorm, cauſed a line of circumvallation to be drawn quite round it, with a large and deep ditch; reckoning, that if all communication with the country were cut off, the beſieged would be obliged to ſurrender through famine. That his troops might not be too much fatigued, he divided his army into twelve bodies, appointing each body its month to guard the trenches; but the beſieged, looking upon themſelves to be out of all danger by reaſon of their high walls and magazines, inſulted him from the ramparts, and looked upon all the trouble he gave himſelf as ſo much unprofitable labour.

After Cyrus had ſpent two whole years before Babylon, without making any progreſs in the ſiege, he at laſt thought of the following ſtratagem, which put him in poſſeſſion of it. He was informed, that a great annual ſolemnity was to be held at Babylon; and that the inhabitants on that occaſion were accuſtomed to ſpend the whole night in drinking and debauchery. This he therefore thought a proper time for ſurpriſing them; and accordingly ſent a ſtrong detachment to the head of the canal leading to the great lake, with orders, at a certain time, to break down the great bank which was between the lake and the canal, and to turn the

Babylonia. whole current into the lake. At the ſame time he appointed one body of troops at the place where the river entered the city, and another where it came out; ordering them to march in by the bed of the river as ſoon as they ſhould find it fordable. Towards the evening he opened the head of the trenches on both ſides the river above the city, that the water might diſcharge itſelf into them; by which means, and the breaking down of the great dam, the river was ſoon drained. Then the two abovementioned bodies of troops, according to their orders, entered the channel; the one commanded by Gobryas and the other by Gadates: and finding the gates all left open by reaſon of the diſorders of that riotous night, they penetrated into the very heart of the city without oppoſition; and meeting, according to agreement, at the palace, they ſurpriſed the guards, and cut them in pieces. Thoſe who were in the palace opening the gates to know the cauſe of this confuſion, the Perſians ruſhed in, took the palace, and killed the king, who came out to meet them ſword in hand. Thus an end was put to the Babylonian empire; and Cyrus took poſſeſſion of Babylon for one called in Scripture *Darius the Mede*, moſt probably *Cyaxares* II. uncle to Cyrus. From this time Babylonia never was erected into a diſtinct kingdom, but hath always followed the fortune of thoſe great conquerors who at different times have appeared in Aſia. It is now frequently the object of contention between the Turks and Perſians. See ASSYRIA.

Concerning the nature of the country, manners, cuſtoms, &c. of the ancient Babylonians, the following account is collected by M. Sabbathier.

"As all the nations under the dominion of Cyrus, beſide the ordinary tributes, were obliged to maintain him and his army, the monarch and his troops were ſupported by all Aſia. The country of Babylon alone was obliged to maintain him four months of the year; its fertility, therefore, yielded a third of the produce of Aſia. The government of this country, which the Perſians termed *ſatrapy*, was richer, and more extenſive, than any of the reſt. It maintained for the king, beſides the war-horſes, a ſtud of 800 ſtallions, and 16,000 mares. So great a number of Indian dogs were likewiſe bred in this province for the king, that four of its cities kept thoſe animals; and in return, they were exempted from all taxes and tributes.

"It rained very ſeldom in this country, according to Herodotus. The earth was watered by the river, which was here diffuſed by human induſtry, as the Nile is over Egypt by nature: for all the country of Babylon was divided by canals, the greateſt of which was navigable, and flowed from ſouth to north, from the Euphrates to the Tigris. In ſhort, it was one of the fineſt countries for corn in the world; but for producing trees, the fig-tree, the vine and the olive, it was not famous. It was ſo luxuriant in grain, that it commonly yielded a hundred times more than what was ſown; and in its good years it yielded three hundred times more than it received. The leaves of its wheat and barley were four inches broad. 'Though I know,' ſays Herodotus, 'that the millet and the ſeſame of that country grow to the ſize of trees, I will not deſcribe them particularly; leſt thoſe who have not been in Babylonia ſhould think my account fabulous.'

"They had no oil but what they made from Indian corn. The country abounded with palm-trees, which grew ſpontaneouſly; and moſt of them bore fruit, of which the inhabitants made bread, wine, and honey. They cultivated theſe trees and their fig-trees in the ſame manner. Some of them, as of other trees, the Greeks called *male ones*. They tied the fruit of the male to the trees which bore dates; that the moſquito, leaving the male, might cauſe the date to ripen, by penetrating it; for without that aſſiſtance it came not to maturity. Moſquitos bred in the male palms as in the wild fig-trees. Babylonia.

"But we muſt not here omit to give an account of the peculiar and ſurpriſing conſtruction of their boats of ſkins, in which they ſailed along the river to Babylon. Theſe boats were invented by the Armenians, whoſe country lay north from Babylonia. They made them with poles of willow, which they bent, and covered with ſkins: the bare ſide of the ſkins they put outwards; and they made them ſo tight, that they reſembled boards. The boats had neither prow nor ſtern, but were of a round form like a buckler. They put ſtraw on the bottom. Two men, each with an oar, rowed them down the river, laden with different wares, but chiefly with palm-wine. Of theſe boats ſome were very large, and ſome very ſmall. The largeſt carried the weight of 500 talents. There was room for an aſs in one of their ſmall boats; they put many into a large one. When they had unloaded, after their arrival at Babylon, they ſold the poles of their boats and the ſtraw; and loading their aſſes with the ſkins, returned to Armenia: for they could not ſail up the river, its current was ſo rapid. For this reaſon they made their boats of ſkins, inſtead of wood; and on their return to Armenia with their aſſes, they applied the ſkins to their former uſe.

"As to their dreſs, they wore a linen ſhirt, which came down to their feet. Over it they wore a woollen robe; their outer garment was a white veſt. Their ſhoes reſembled thoſe of the Thebans. They let their hair grow. On their heads they wore a turban. They rubbed their bodies all over with fragrant liquors. Each man had a ring on his finger, and an elegant cane in his hand, with an apple at the top, or a roſe, a lily, or an eagle, or ſome other figure; for they were not ſuffered to uſe canes without devices.

"With regard to their policy, Herodotus thinks that their beſt law was one which the Heneti, an Illyrian people, likewiſe obſerved in every town and village. When the girls were marriageable, they were ordered to meet in a certain place, where the young men likewiſe aſſembled. They were then ſold by the public crier; but he firſt ſold the moſt beautiful one. When he had ſold her at an immenſe price, he put up others to ſale, according to their degrees of beauty. The rich Babylonians were emulous to carry off the fineſt women, who were ſold to the higheſt bidders. But as the young men who were poor could not aſpire to have fine women, they were content to take the ugliеſt with the money which was given them: for when the crier had ſold the handſomeſt, he ordered the ugliеſt of all the women to be brought; and aſked, if any one was willing to take her with a ſmall ſum of money. Thus ſhe became the wife of him who was moſt eaſily ſatisfied; and thus the fineſt women were ſold; and from the money

Babylonia, Babylonian

money which they brought, ſmall fortunes were given to the ugliеſt, and to thoſe who had any bodily infirmity. A father could not marry his daughter as he pleaſed; nor was he who bought her allowed to take her home, without giving ſecurity that he would marry her. But, after the ſale, if the parties were not agreeable to each other, the law enjoined that the purchaſe-money ſhould be reſtored. The inhabitants of any of their towns were permitted to marry wives at theſe auctions. Such were the early cuſtoms of the Babylonians.

"But they afterwards made a law, which prohibited the inhabitants of different towns to intermarry, and by which huſbands were puniſhed for treating their wives ill. When they had become poor by the ruin of their metropolis, fathers uſed to proſtitute their daughters for gain. There was a ſenſible cuſtom among the Babylonians, worthy to be related. They brought their ſick into the forum, to conſult thoſe who paſſed on their diſeaſes; for they had no phyſicians. They aſked thoſe who approached the ſick, if they ever had the ſame diſtemper? if they knew any one who had it? and how he was cured? Hence, in this country, every one who ſaw a ſick perſon was obliged to go to him, and inquire into his diſtemper.

"They embalmed their dead with honey; and their mourning was like that of the Egyptians.

"There were three Babylonian tribes, who lived only upon fiſh, and who prepared them in the following manner: they dried them in the ſun, and then beat them in a mortar to a kind of flour, which after they had ſifted through linen, they baked it in rolls.

"The Babylonians at firſt worſhipped only the ſun, and the moon; but they ſoon multiplied their divinities. They deified Baal, Bel, or Belus, one of their kings, and Merodach-Baladan. They alſo worſhipped Venus, under the name of *Mylitta*. She and Belus were the principal deities of the Babylonians. They counted their day from ſun-riſe to ſun-riſe. They ſolemnized five days of the year with great magnificence, and almoſt the ſame ceremonies with which the Romans celebrated their Saturnalia.

"The Babylonians were very much addicted to judicial aſtrology. Their prieſts, who openly profeſſed that art, were obliged to commit to writing all the events of the lives of their illuſtrious men; and on a fancied connection between thoſe events and the motions of the heavenly bodies, the principles of their art were founded. They pretended that ſome of their books, in which their hiſtorical tranſactions and revolutions were accurately compared with the courſes of the ſtars, were thouſands of years old. This aſſertion of their judicial aſtrologers we may reaſonably diſpute; but that their aſtronomers had made a long ſeries of obſervations, is inconteſtably true. It is certain that ſome of thoſe obſervations were extant in the days of Ariſtotle, and that they were older than the empire of the Babylonians. See *Hiſtory of* ASTRONOMY.

BABYLONIAN, BABYLONIUS, is uſed in ſome ancient writers, for an aſtrologer, or any thing related to aſtrology. Hence *Babylonia cura*, the art of caſting nativities; and *numeri Babylonii*, the computation of aſtrologers.

BABYLONICA TEXTA, a rich ſort of weavings, or hangings, denominated from the city of Babylon, where the practice of interweaving divers colours in their hangings firſt obtained. Hence alſo Babylonic garments, Babylonic ſkins, Babylonic carpets, houſings, &c. *Babylonica ſolana*, coverings laid over couches, &c. painted with gold, purple, and other colours. Babylonica ‖ Baca.

BABYLONICS, BABYLONICA, in ancient hiſtory, a fragment of the hiſtory of the world, ending at 267 years before Chriſt; and compoſed by Beroſus, or Beroſſus, a prieſt of Babylon, about the time of Alexander. Babylonics are ſometimes alſo cited in ancient writers by the title of *Chaldaics*. The Babylonics were very conſonant with ſcripture, as Joſephus and the ancient Chriſtian chronologers aſſure; whence the author is uſually ſuppoſed to have conſulted the Jewiſh writers. Beroſus ſpeaks of an univerſal deluge, an ark, &c. He reckons ten generations beween the firſt man and the deluge; and marks the duration of the ſeveral generations by *ſaroi*, or periods of 223 lunar months; which, reduced to years, differ not much from the chronology of Moſes.—The babylonics conſiſted of three books, including the hiſtory of the ancient Babylonians, Medes, &c. But only a few imperfect extracts are now remaining of the work; preſerved chiefly by Joſephus and Syncellus, where all the paſſages of citations of ancient authors out of Beroſus are collected with great exactneſs, Annius of Viterbo, to ſupply the loſs, forged a complete Beroſus out of his own head. The world has not thanked him for the impoſture.

BABYROUSSA, in zoology, a ſynomine of a ſpecies of ſus. See SUS.

BAC, in navigation, is uſed for a praam, or ferry-boat.

BAC, in brewing, a large flat kind of tub, or veſſel, wherein the wort is put to ſtand and cool before boiling. The ingredients of beer paſs through three kinds of veſſels. They are maſked in one, worked in another, and cooled in a third, called *bacs* or *coolers*.

BAC, in diſtillery, veſſels into which the liquor to be fermented is pumped from the cooler, in order to be worked with the yeſt.

BAC-Maker, is one who makes liquor-bacs, under-bacs, coolers, maſh-tons, working-tons, &c. for the brewers. The workmanſhip is partly carpentry, in a particular manner, for it muſt be tight enough to hold liquor; and partly cooperage, *viz.* the maſh-tun, or vat, which is hooped. There are not many of this trade; and it requires chiefly ſtrength, with a little art. A ſmall ſtock of ſtuff, beſides tools, will ſet a man up tolerably well; but, with 200l. or 300l. he will make a good figure in buſineſs.

BACA, or BAZA, a town of Spain, in the kingdom of Granada. W. Long. 3. 6. N. Lat. 37. 18. It is ſituated in a valley called *Hoya de Baza*. It is encompaſſed with old walls, and has a caſtle half ruined. It contains about 4000 houſes, but has nothing remarkable except the church dedicated to the Virgin Mary. The land about it is well cultivated for half a league round, and is fertile in wheat, wine, honey, hemp, and flax, being watered by the little river Guadalantin.

Bacacum | Baccharis.

BACACUM, a town of the Nervii in Gallia Belgica; now *Bavay*, in Hainault. E. Long. 3. 30. N. Lat. 50. 25.

BACAIM, a handſome ſea-port town of the kingdom of Viſapour on the Malabar coaſt in Aſia. It is ſubject to the Portugueſe; and ſtands in E. Long. 73. 10. N. Lat. 19. 0.

BACASERAY, a town in the peninſula of Crim Tartary, and, as the khan uſually takes up his reſidence there, it may be conſidered as the capital of the country. E. Long. 35. 10. N. Lat. 45. 30.

BACCA, BERRY, in botany, is uſed to ſignify ſuch fruits as conſiſt of a pericarpium full of juice and ſeeds, without any valves.

BACANTIBI, in eccleſiaſtical antiquity, wandering clerks, who ſtrolled from church to church.—— The word ſeems formed by corruption from *vacantivi*.

BACCALARIA, in middle age writers, denotes a kind of country-farms, conſiſting of ſeveral manſes.

Bacalaria dominicaria, or *indominicata*, was more particularly uſed for a farm belonging to the lord, and kept in his own hands.

BACCARACH, a town of Germany in the lower Palatinate; formerly imperial and free, but now ſubject to the elector Palatine. It is famous for excellent wine; and is ſituated on the Rhine, in E. Long. 7. 5. N. Lat. 49. 57.

BACCHÆ, in antiquity, the prieſteſſes of Bacchus, who celebrated the *orgia*, or myſteries of that god.—The word was alſo uſed for the ivy crowns or garlands worn by the prieſts of Bacchus, in offering ſacrifices to him.

BACCHANALIA, feaſts celebrated in honour of Bacchus by the ancients. The two moſt remarkable were called the *greater* and *leſſer*. The latter, called *lenæa*, from a word ſignifying a *wine-preſs*, were held in the open fields about autumn; the greater, called *Dionyſia*, from one of the names of Bacchus, were celebrated in the city, about the ſpring-time. Both theſe feaſts were accompanied with games, ſpectacles, and theatrical repreſentations, and it was at this time the poets contended for the prize of poetry. Thoſe who were initiated into the celebration of theſe feaſts, repreſented ſome Silenius; others, Pan; others, Satyrs; and in this manner appeared in public, night and day, counterfeiting drunkenneſs, dancing obſcenely, and committing all kinds of licentiouſneſs and debauchery. See the article BACCHUS.

BACCHARIS, PLOUGHMAN'S SPIKENARD: A genus of the polygamia ſuperflua order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ diſcoides*. The characters are: It has a naked receptacle, and hairy papus; with a cylindrical imbricated calyx, and feminine florets mixed with the hermaphrodite ones. There are ſeven ſpecies, all natives of warm climates; but none of them merit notice except the two following. 1. The ivæfolia, or African tree-groundſel, is a native of the Cape of Good Hope, as alſo of Peru and other warm parts of America. It grows to the height of five or ſix feet; and though there is little beauty in the flower, has been long admitted into the gardens of the curious. It is pretty hardy, and will live abroad in moderate winters in England, but is uſually kept in green-houſes and placed abroad only in ſummer. It may be propagated either by cuttings or ſeeds, which ripen well in this country. 2. The Halimifolia, or Virginia groundſel-tree, is a native of Virginia and other parts of North-America. It grows about ſeven or eight feet high, with a crooked ſhrubby ſtem; and flowers in October: the flowers are white, and not very beautiful; but the leaves continuing green, has occaſioned this ſhrub to be admitted into many curious gardens. It may be propagated by cuttings; and will live very well in the open air, though ſevere froſts will ſometimes deſtroy it.

Bacchi | Bacchus.

BACCHI, in mechanics, a kind of ancient machines, in form of goats, uſed by Jupiter, in his wars againſt the giants. Rudbeck deſcribes two kinds of bacchi, one made like the battering-ram, wherewith Jupiter demoliſhed the enemy's fortifications; the other contrived to caſt fire out of, from whence the Greeks are conjectured to have framed their idea of chimera.

BACCHIC, ſomething relating to the ceremonies of Bacchus. The celebrated *intaglio*, called Michael Angelo's ring, is a repreſentation of a bacchic feaſt.

Bacchic ſong, is ſometimes uſed for a *chanſon à boire*, or compoſition to inſpire jollity. But in a more proper ſenſe, it is reſtrained to a dithyrambic ode or hymn.

BACCHINI (Benedict), a Benedictine monk, and one of the moſt learned men in his time, was born at Borgo San Domino in 1651; and wrote a great number of books in Latin and Italian, the moſt conſiderable of which is a Literary Journal. He died at Bologna in 1721, aged 70.

BACCHIUS, a follower of Ariſtoxenus, ſuppoſed by Fabricius to have been tutor to the emperor Marcus Antoninus, and conſequently to have lived about A. C. 140. He wrote in Greek a very ſhort introduction to muſic in dialogue, which, with a Latin tranſlation thereof, Meibomius has publiſhed. It ſeems it was firſt publiſhed in the original by Merſennus, in his Commentary on the firſt ſix chapters of Geneſis; and that afterwards he publiſhed a tranſlation of it in French, which Meibomius, in the preface to his edition of the ancient muſical authors, cenſures as being groſsly erroneous.

BACCHIUS, in ancient poetry, a kind of foot compoſed of a ſhort ſyllable, and two long ones; as the word [ăvārī]. It takes its name from the god Bacchus, becauſe it frequently entered into the hymns compoſed in his honour. The Romans called it likewiſe *ænotrius*, *tripodius*, *ſaltans*.

BACCHUS, in Heathen mythology, the god of wine, with whoſe fabulous adventures every ſchool-boy is acquainted. This perſonage is ſeldom named in modern times, but as a ſenſual encourager of feaſt and jollity; but he was regarded in a more reſpectable light by the ancients, who worſhipped him in different countries under the following appellations: In Egypt, he was called *Oſiris*; in Myſia, *Fanaces*; in India; *Dionyſius*; *Liber*, throughout the Roman dominions; *Adoneus*, in Arabia; and *Pentheus*, by the Lucanians. Mythologiſts furniſh reaſons for all theſe different names given to the ſame god, which may be ſeen in the ſecond volume of Banier's Mythology.

It is natural to ſuppoſe that the Greeks and Romans, as uſual, beſtowed upon the one Bacchus which they wor-

Bacchus

worſhipped, the ſeveral actions and attributes of the many divinities known by that name, and by other equivalent denominations in different countries. However, antiquity chiefly diſtinguiſhed two gods under the title of *Bacchus:* that of Egypt, the ſon of Ammon, and the ſame as Oſiris; and that of Thebes in Bœotia, the ſon of Jupiter and Semele.

The Egyptian Bacchus was brought up at Nyſa, a city of Arabia Felix, whence he acquired the name of *Dionyſius*, or the God of Nyſa; and this was the conqueror of India. Though this Bacchus of the Egyptians was one of the elder gods of Egypt, yet the ſon of Semele was the youngeſt of the Grecian deities. Diodorus Siculus tells us, that Orpheus firſt deified the ſon of Semele by the name of Bacchus, and appointed his ceremonies in Greece, in order to render the family of Cadmus, the grandfather of the Grecian Bacchus, illuſtrious.

The great Bacchus, according to Sir Iſaac Newton, flouriſhed but one generation before the Argonautic expedition. This Bacchus, ſays Hermippus, was potent at ſea, conquered eaſtward as far as India, returned in triumph, brought his army over the Helleſpont, conquered Thrace, and left muſic, dancing, and poetry there. And, according to Diodorus Siculus, it was the ſon of Semele who invented farces and theatres, and who firſt eſtabliſhed a muſic-ſchool, exempting from all military functions ſuch muſicians as diſcovered great abilities in their art; on which account, ſays the ſame author, muſicians formed into companies have ſince frequently enjoyed great privileges.

* *Hiſtory of Muſic.* p. 298. *et ſeq.*

Dr Burney * obſerves, that the dithyrambics which gave birth to dramatic repreſentations, are as ancient as the worſhip of Bacchus in Greece; and there is little doubt but that the ceremonies of his myſteries gave riſe to the pomp and illuſions of the theatre. Many of the moſt ſplendid exhibitions upon the ſtage for the entertainment of the people of Athens and Rome, being performed upon the feſtivals of Bacchus, gave occaſion to the calling all thoſe that were employed in them, whether for ſinging, dancing, or reciting, *ſervants of Bacchus*.

Pauſanias, in his Attics, ſpeaks of a place at Athens conſecrated to *Bacchus the ſinger;* thus named, he ſays, for the ſame reaſon as Apollo is called the *chief* and *conductor* of the muſes. Whence it ſhould ſeem that Bacchus was regarded by the Athenians not only as the god of wine, but of ſong; and it muſt be owned, that his followers, in their cups, have been much inclined to ſinging ever ſince. Indeed we are certain, that in none of the orgies, proceſſions, triumphs, and feſtivals, inſtituted by the ancients to the honour and memory of this prince of *bons vivans*, muſic was forgotten, as may be ſtill gathered from ancient ſculpture, where we find not only that muſicians, male and female, regaled him with the lyre, the flute, and with ſong; but that he was accompanied by fawns and ſatyrs playing upon timbrels, cymbals, bagpipes, and horns: theſe Suidas calls his minſtrels; and Strabo gives them the appellations of *Bacchi, Sileni, Satyri, Bacchæ, Lenæ, Thyæ, Mamillones, Naiades, Nymphæ*, and *Tityri*. Theſe repreſentations have furniſhed ſubjects for the fineſt remains of ancient ſculpture; and the moſt voluptuous paſſages of ancient poetry are deſcriptions of the orgies and feſtivals of Bacchus. See ORGIA.

Bacchylides

BACCHYLIDES, a famous Greek poet, was the nephew of Simonides, and the cotemporary and rival of Pindar. Both ſung the victories of Hiero at the public games. Beſides odes to athletic victors, he was author of Love Verſes; Proſodies; Dithyrambics; Hymns; Pæans; Hyporchemes; Parthenia, or ſongs to be ſung by a chorus of virgins at feſtivals. The chronology of Euſebius places the birth of Bacchylides in the 82d Olympiad, about 450 B. C.

BACCIO, or BACCIUS, (Andrew), a celebrated phyſician of the 16th century, born at St Elpideo. He practiſed phyſic at Rome with great reputation, and was firſt phyſician to pope Sixtus V. The moſt ſcarce and valuable of his works are, 1. *De thermis.* 2. *De naturali vinorum hiſtoria.* 3. *De venenis et antidotis.* 4. *De gemmis ac lapidibus pretioſis.*

BACCIO (Fra. Bartolomeo), called *Bartelemi di S. Marco*, a celebrated painter of hiſtory and portrait, was born at Savignano near Florence in 1469, and was a diſciple of Coſumo Roſelli; but his principal knowledge in the art of painting was derived from Leonardo da Vinci. He underſtood the true principles of deſign better than moſt maſters of his time, and was alſo a conſiderable painter in perſpective; which induced Raphael to have recourſe to him after he had quitted the ſchool of Perugino; and under his direction likewiſe Raphael ſtudied the art of managing and uniting colours, as well as the rules of perſpective. Some years after the departure of Raphael from Florence, Baccio viſited Rome; and by the obſervations he made on the antiques, and the works of Raphael which were then the admiration of the whole world, he was extremely improved, and manifeſted his acquired abilities by a picture of S. Sebaſtian, which he finiſhed at his return to Florence. It was ſo well deſigned, ſo naturally and beautifully coloured, and had ſo ſtrong an expreſſion of pain and agony, that it was removed from the place where it was publicly ſeen (in the chapel of a convent), as it had been obſerved to have made too ſtrong an impreſſion on the imaginations of many women who beheld it. He was very laborious, and made nature his perpetual ſtudy; he deſigned the naked correctly; his figures had a great deal of grace, and his colouring was admirable. He is accounted to have been the firſt inventor of that machine called a *layman* by the artiſts, and which to this day is in general uſe. Upon that he placed his draperies, to obſerve with greater exactneſs their natural and their more elegant folds. A capital picture of the aſcenſion by Baccio, is in the Florentine collection. He died in 1517.

Bachelor.

BACHELOR, or BATCHELOR, a common term for a man not married, or who is yet in a ſtate of celibacy.—The Roman cenſors frequently impoſed fines on old bachelors. Dion Halicarnaſſeus mentions an old conſtitution, by which all perſons of full age were obliged to marry. But the moſt celebrated law of this kind was that made under Auguſtus, called the *lex Julia de maritandis ordinibus*; by which bachelors were made incapable of legacies or inheritances by will, unleſs from their near relations. This brought many to marry, according to Plutarch's obſervation, not ſo much

Bachelor. much for the ſake of raiſing heirs to their own eſtates, as to make themſelves capable of inheriting thoſe of other men.—The rabbins maintain, that, by the laws of Moſes, every body, except ſome few particulars, is obliged in conſcience to marry at 20 years of age: this makes one of their 613 precepts. Hence thoſe maxims ſo frequent among their caſuiſts, that he who does not take the neceſſary meaſures to leave heirs behind him, is not a man, but ought to be reputed a homicide.—Lycurgus was not more favourable: by his laws, bachelors are branded with infamy, excluded from all offices civil and military, and even from the ſhows and public ſports. At certain feaſts they were forced to appear, to be expoſed to the public deriſion, and led round the market-place. At one of their feaſts, the women led them in this condition to the altars, where they obliged them to make *amende honourable* to nature, accompanied with a number of blows and laſhes with a rod at diſcretion. To complete the affront, they forced them to ſing certain ſongs compoſed in their own deriſion.—The Chriſtian religion is more indulgent to the bachelor ſtate: the ancient church recommended it as in ſome circumſtances preferable to, and more perfect than, the matrimonial. In the canon law, we find injunctions on bachelors, when arrived at puberty, either to marry or to turn monks and profeſs chaſtity in earneſt.—In England, there was a tax on bachelors, after 25 years of age, 12 l. 10s. for a duke, a common perſon 1 s. by 7 Wil. III. 1695. In Britain, at preſent, they are taxed by an extra-duty on their ſervants. Every man of the age of 21 years and upwards, never having been married, who ſhall keep one male ſervant or more, ſhall pay 1 l. 5 s. for each above or in addition to the ordinary duties leviable for SERVANTS. Every man of the age of 21 years and upwards, never having been married, keeping one female ſervant, ſhall pay 2 s. 6 d. in addition to the former 2 s. 6 d.; 5 s. in addition for each, if he has two female ſervants; and 10s. in addition for each for three or more female ſervants.

BACHELOR, was anciently a denomination given to thoſe who had attained to knighthood, but had not a number of vaſſals ſufficient to have their banner carried before them in the field of battle; or if they were not of the order of Bannerets, were not of age to diſplay their own banner, but obliged to march to battle under another's banner. It was alſo a title given to young cavaliers, who, having made their firſt campaign, received the military girdle accordingly. And it ſerved to denominate him who had overcome another in a tournament, the firſt time he ever engaged.—The word *bachelor*, in a military ſenſe, is derived by Cujas from *buccellarius*, a kind of cavalry, anciently in great eſteem. Du Cange deduces it from *baccalaria*, a kind of fees or farms, conſiſting of ſeveral pieces of ground, each whereof contained 12 acres or as much as two oxen would plough; the poſſeſſors of which baccalaria were called *bachelors*. Caſeneuve and Altaſerra derive bachelor from *baculus* or *bacillus*, "a ſtaff," becauſe the young cavaliers exerciſed themſelves in fighting with ſtaves. Martinius derives it from *baccalaureus*, i. e. *bacca laurea donatus*, in alluſion to the ancient cuſtom of crowning poets with laurel, *baccis lauri*, as was the caſe with Petrarch at Rome in 1341. Alciat and Vives are of the ſame opinion: nor is this etymology improbable.

Knights-BACHELORS, the moſt ancient, but the loweſt Bachelor. order of knights in England; known by the name of *knights* only. They are ſtyled *knights bachelors*, either (according to ſome) as denoting their degree, *quaſi bas chevaliers*; or, according to others, becauſe this title does not deſcend to their poſterity.

The cuſtom of the ancient Germans was to give their young men a ſhield and a lance in the great council: this was equivalent to the *toga virilis* of the Romans. Before this, they were not permitted to bear arms, but were accounted as part of the father's houſehold; after it, as part of the public. Hence ſome derive the uſage of knighting, which has prevailed all over the weſtern world, ſince its reduction by colonies, from thoſe northern heroes. Knights are called in Latin *equites aurati: aurati*, from the gilt ſpurs they wore; and *equites*, becauſe they always ſerved on horſeback: for it is obſervable, that almoſt all nations call their knights by ſome appellation derived from an horſe. They are alſo called in our law *milites*, becauſe they formed a part, or indeed the whole, of the royal army, in virtue of their feodal tenures; one condition of which was, that every one who held a knight's fee (which in Henry II.'s time amounted to 20 l. *per annum*) was obliged to be knighted, and attend the king in his wars, or pay a fine for his non-compliance. The exertion of this prerogative, as an expedient to raiſe money in the reign of Charles I. gave great offence, though warranted by law and the recent example of Queen Elizabeth. At the Reſtoration, it was, together with all other military branches of the feodal law, aboliſhed: and it now only exiſts as an honorary title; though, on account of its indiſcriminate attainment, not very generally regarded. It is conferred indiſcriminately upon gownſmen, burghers, and phyſicians, by the king's lightly touching the perſon, who is then kneeling, on the right ſhoulder with a drawn ſword, and ſaying, *Riſe, Sir*. See the articles KNIGHT and NOBILITY.

BACHELORS, in an univerſity ſenſe, are perſons that have attained to the baccalaureate, or who have taken the firſt degree in the liberal arts and ſciences.

The degree of bachelor was firſt introduced in the 13th century by Pope Gregory IX. but it remains ſtill unknown in Italy. At Oxford, before a perſon is intitled to the degree of *bachelor of arts*, he muſt have ſtudied there four years; three years more to become maſter of arts; and ſeven more to commence bachelor of divinity.—At Cambridge, to commence bachelor of arts, he muſt have been admitted near four years; and above three years more before he commences maſter; and ſeven more ſtill to become bachelor of divinity. He may commence bachelor of law after having ſtudied it ſix years.—At Paris, to paſs bachelor in theology, a perſon muſt have ſtudied two years in philoſophy and three years in theology, and held two acts of examination in the Sorbonne.—Bachelors in the canon law are admitted after two years ſtudy in the ſame, and ſuſtaining an act according to the forms. A bachelor of phyſic muſt have ſtudied two years in medicine after having been four years maſter of arts in the univerſity, and have ſtood an examination; after which he is inveſted with the fur, in order to be licenſed.—In the univerſity of Paris, before the foundation of divinity-profeſſorſhips, thoſe who had ſtudied divinity ſix years were

Bachelors
Back.

were admitted to go through their courſe, whence they were called *baccalarii curſores*; and as there were two courſes, the firſt employed in explaining the Bible during three ſucceſſive years, the ſecond for explaining the maſter of the ſentences for one year, thoſe who were in the Bible-courſe were called *baccalarii Biblici*, and thoſe arrived at the ſentences *baccalarii ſententiarii*. And, laſtly, thoſe who had gone through both were denominated *baccalarii formati*, or *formed bachelors*.

At preſent, *formed bachelor* denotes a perſon who has taken the degree regularly after the due courſe of ſtudy and exerciſes required by the ſtatutes; by way of oppoſition to a *current bachelor*, who is admitted in the way of grace, or by diploma.

We alſo find mention of bachelors of the church, *baccalarii eccleſiæ*. The biſhop with his canons and *baccalarii, cum conſilio et conſenſu omnium canonicorum ſuorum et baccalariorum*.

BACHELORS, in the Livery companies of London, are thoſe not yet admitted to the livery. Theſe companies generally conſiſt of a maſter, two wardens, the livery, and the bachelors, who are yet but in expectation of dignity in the company, and have their function only in attendance on the maſter and wardens. They are alſo called *yeomen*.

BACHELOR is alſo a name given in the ſix companies of merchants at Paris to the elders, and ſuch as having ſerved the offices, have a right to be called by the maſters and wardens to be preſent with them, and aſſiſt them in ſome of the functions, particularly in what relates to the *chef-d'oeuvres* or maſter-pieces, of ſuch as are candidates for being admitted maſters.

BACHERAC, a town of the Palatine of the Rhine, ſituated on the weſtern ſhore of that river, in E. Long. 7°. and N. Lat. 58°. It is remarkable for excellent wine, from thence called *Bacherac*.

BACHIAN, one of the Molucca iſlands, belonging to the Dutch; ſituated under the Equator, in E. Long. 125°.

BACHU, a city of Shirvan in Perſia, and the beſt haven in the Caſpian ſea. It is defended by a double wall, as alſo by a ditch and redoubts, made by the Ruſſians when they were maſters of the place. It had a ſumptuous caſtle, but it is reduced to a ruinous ſtate by the Ruſſians. Formerly many merchants reſided here, and carried on a conſiderable traffic in raw ſilk; but that commerce is now given up. All the country round is much impregnated with ſulphur, which renders the water very unpleaſant. The neighbourhood of this city ſupplies the countries adjacent with naphtha, brimſtone, and rock-ſalt; and is the only place thereabouts which produces ſaffron. Round Bachu are ſeveral very ſteep craggy mountains, on which are ſtrong watch towers. E. Long. 49. 5. N. Lat. 40. 0

BACK, *Back-Bone*, or SPINE. See Anatomy, n° 30.

BACK, in the menage, and among farriers. A horſe's back ſhould be ſtraight, not hollow, which is called *ſaddle-backed*: horſes of this kind are generally light, and carry their heads high, but want in ſtrength and ſervice. A horſe with a weak back is apt to ſtumble. In the French riding-ſchools, to mount a horſe *a dos*, is to mount him bare-backed, without a ſaddle.

Back-gammon.

BACK-Gammon, an ingenious game played with dice, upon a table, by two perſons.

Manner of playing the game. The table is divided into two parts, upon which there are 24 black and white ſpaces, called points. Each adverſary has 15 men, black and white, to diſtinguiſh them; and they are diſpoſed of in the following manner: Suppoſing the game to be played into the right-hand table, two are placed upon the ace point in the adverſary's table, five upon the ſix point in the oppoſite table, three upon the cinque point in the hithermoſt table, and five on the ſix point in the right-hand table. The grand object in this game is for each player to bring the men round into his right-hand table, by throwing with a pair of dice thoſe throws that contribute towards it, and at the ſame time prevent the adverſary doing the like. The firſt beſt throw upon the dice is eſteemed aces, becauſe it ſtops the ſix point in the outer table, and ſecures the cinque in the thrower's table; whereby the adverſary's two men upon the thrower's ace point cannot get out with either quatre, cinque, or ſix. This throw is an advantage often given to the antagoniſt by the ſuperior player.

When he carries his men home in order to loſe no point, he is to carry the moſt diſtant man to his adverſary's bar point, that being the firſt ſtage he is to place it on; the next ſtage is ſix points farther, viz. in the place where the adverſary's five men are firſt placed out of his tables. He muſt go on in this method till all his men are brought home, except two, when by loſing a point, he may often ſave the gammon, by throwing two fours or two fives.

When a hit is only played for, he ſhould endeavour to gain either his own or adverſary's cinque point; and if that fails by his being hit by the adverſary, and he finds him forwarder than himſelf, in that caſe he muſt throw more men into the adverſary's tables; which is done in this manner: He muſt put a man upon his cinque or bar point; and if the adverſary neglects to hit it, he may then gain a forward game inſtead of a back game: but if the adverſary hits him, he ſhould play for a back game; and then the greater number of men which are taken up makes his game the better, becauſe by theſe means he will preſerve his game at home: and then he ſhould endeavour to gain both his adverſary's ace and the trois points, or his ace and deuce points, and take care to keep three men upon the adverſary's ace point, that in caſe he hits him from thence, that point may remain ſtill ſecure to himſelf.

A back game ſhould not be played for at the beginning of a ſet, becauſe it would be a great diſadvantage, the player running the riſk of a gammon to win a ſingle hit.

Rules for playing at ſetting out all the throws on the dice, when the player is to play for a gammon or for a ſingle hit (A). 1. Two aces are to be played on the cinque point and bar point, for a gammon or for a hit. 2. Two ſixes, to be played on the adverſary's bar

(A) The rules marked thus are for a gammon only; thoſe marked thus * are for a hit only.

Back-gammon.

bar point and on the thrower's bar point, for a gammon or for a bit. 3. † Two trois, to be played on the cinque point, and the other two on the trois point in his own tables, for a gammon only. 4. † Two deuces, to be played on the quatre point in his own tables, and two to be brought over from the five men placed in the adverſary's tables for a gammon only. 5. † Two fours, to be brought over from the five men place in the adverſary's tables, and to be put upon the cinque point in his own tables for a gammon only. 6. Two fives, to be brought over from the five men placed in the adverſary's tables, and to be put on the trois point in his own tables, for a gammon or for a hit. 7. Size ace, he muſt take his bar point for a gammon or for a hit. 8. Size deuce, a man to be brought from the five men placed in the adverſary's tables, and to be placed in the cinque point in his own tables, for a gammon or for a hit. 9. Six and three, a man to be brought from the adverſary's ace point, as far as he will go, for a gammon or for a hit. 10. Six and four, a man to be brought from the adverſary's ace point, as far as he will go, for a gammon or for a hit. 11. Six and five, a man to be carried from the adverſary's ace point, as far as he can go, for a gammon or for a hit. 12. Cinque and quatre, a man to be carried from the adverſary's ace point, as far as he can go, for a gammon or for a hit. 13. Cinque trois to make the trois point in his table, for a gammon or for a hit. 14. Cinque deuce, to play two men from the five placed in the adverſary's tables, for a gammon or for a hit. 15. † Cinque ace, to bring one man from the five placed in the adverſary's tables for the cinque, and to play one man down on the cinque point in his own tables for the ace, for a gammon only. 16. Quatre trois, two men to be brought from the five place in the adverſary's tables, for a gammon or for a hit. 17. Quatre deuce, to make the quatre point in his own tables, for a gammon or for a hit. 18. † Quatre ace, to play a man from the five placed in the adverſary's tables for the quatre; and for the ace, to play a man down upon the cinque point in his own tables, for a gammon only. 19. † Trois deuce, two men to be brought from the five placed in the adverſary's tables, for a gammon only. 20. Trois ace, to make the cinque point in his own tables, for a gammon or for a hit. 21. † Deuce ace, to play one man from the five men placed in the adverſary's table for the deuce; and for the ace to play a man down upon the cinque point in his own tables, for a gammon only. 22. * Two trois, two of them to be played on the cinque point in his own tables, and with the other two he is to take the quatre point in the adverſary's tables. 23. * Two deuces, two of them are to be played on the quatre point in his own tables, and with the other two he is to take the trois point in the adverſary's tables. By playing theſe two caſes in this manner, the player avoids being ſhut up in the adverſary's tables, and has the chance of throwing out the tables to win the hit.

24. * Two fours, two of them are to take the adverſary's cinque point in the adverſary's tables, and for the other two, two men are to be brought from the five placed in the adverſary's tables. 25. * Cinque ace, the cinque ſhould be played from the five men placed in the adverſary's tables, and the ace from the adverſary's ace point. 26. * Quatre ace, the quatre to be played from the five men placed in the adverſary's ace point. 27. * Deuce ace, the deuce to be played from the five men placed in the adverſary's tables, and the ace from the adverſary's ace point.

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The three laſt chances are played in this manner; becauſe an ace laid down in the adverſary's tables, there is a probability of throwing deuce ace, trois deuce, quatre trois, or ſize cinque, in two or three throws; either of which throws ſecures a point, and gives the player the beſt of the hit.

Cautions, &c. The player muſt underſtand by the directions given to play for a gammon, that he is to make ſome blots on purpoſe, the odds being in his favour that they are not hit; but if it ſhould happen that any blot is hit, as in this caſe there will be three men in the adverſary's tables, he muſt then endeavour to ſecure the adverſary's cinque, quatre, or trois point, to prevent a gammon, and muſt be very cautious of his fourth man's not being taken up.

He muſt not crowd his game at any time if he can help it; that is to ſay, he ſhould not put many men either upon the trois or deuce points in his own tables, being the ſame as loſing thoſe men not having them in play. Beſides, by crowding the game, and attempting to ſave a gammon, the player is often gammoned. His game being crowded in his own tables, the adverſary has room to play as he thinks proper.

The following calculations will ſhow the odds of entering a ſingle man upon any certain number of points; and accordingly the game ſhould be played.

It is neceſſary to know that there are thirty-ſix chances upon two dice, and the points that are upon theſe thirty-ſix chances are as follow.

Viz.	Points.
2 Aces - -	4
2 Deuces - -	8
2 Trois - -	12
2 Fours - -	16
2 Fives - -	20
2 Sixes - -	24
6 And 5 twice -	22
6 And 4 twice -	20
6 And 3 twice -	18
6 And 2 twice -	16
6 And 1 twice -	14
5 And 4 twice -	18
5 And 3 twice -	16
5 And 2 twice -	14
5 And 1 twice -	12
4 And 3 twice -	14
4 And 2 twice -	12
4 And 1 twice -	10
3 And 2 twice -	10
3 And 1 twice -	8
2 And 1 twice -	6

Divide by 36)294(8
288

and it proves, that upon an average the player has a right to 8 points each throw. 6

The

Back-gammon.

The chances upon two dice calculated for back-gammon are as follow.

2 Sixes - -	1
2 Fives - -	1
2 Fours - -	1
2 Trois - -	1
2 Deuces - -	1
† 2 Aces - -	1
6 And 5 twice -	2
6 And 4 twice -	2
6 And 3 twice -	2
6 And 2 twice -	2
† 6 And 1 twice -	2
5 And 4 twice -	2
5 And 3 twice -	2
5 And 2 twice -	2
† 5 And 1 twice -	2
4 And 3 twice -	2
4 And 2 twice -	2
† 4 And 1 twice -	2
3 And 2 twice -	2
† 3 And 1 twice -	2
† 2 And 1 twice -	2
	36

As it may ſeem difficult to find out by this table of thirty-ſix chances what are the odds of being hit upon a certain or flat die, let the following method be purſued.

The player may obſerve in the table that what are thus † marked are,

† 2 Aces -	1
† 6 And 1 twice -	2
† 5 And 1 twice -	2
† 4 And 1 twice -	2
† 3 And 1 twice -	2
† 2 And 1 twice -	2
Total	11
Which deducted from -	36
There remain -	25

So that it appears it is twenty-five to eleven againſt hitting an ace upon a certain or flat die.

The above method holds good with reſpect to any other flat die. For example, what are the odds of entering a man upon 1, 2, 3, 4, or 5 points?

Anſwer.

To enter it upon	for	againſt		for	ag.
1 point is	11	to 25	Or about	4	to 9
2 points	20	- 16	-	5	4
3 -	27	- 9	-	3	1
4 -	32	- 4	-	8	1
5 -	35	- 1	-	35	1

The following table ſhows the odds of hitting with any chance, in the reach of a ſingle die.

To hit upon	for	againſt		for	ag.
1 is -	11	to 25	Or about -	4	to 9
2 -	12	- 24	-	1	- 2
3 -	14	- 22	-	2	- 3
4 -	15	- 21	-	5	- 7
5 -	15	- 21	-	5	- 7
6 -	17	- 19	-	$8\frac{1}{2}$	- $9\frac{1}{2}$

Back-gammon.

The odds of hitting with double dice are as follow.

To hit upon	for	againſt		for	ag.
7 is -	6	to 30	Or about -	1	to 5
8 -	6	30	-	1	5
9 -	5	31	-	1	6
10 -	3	33	-	1	11
11 -	2	34	-	1	17
12 -	1	36	-	1	35

How to find out the odds of being hit upon a ſix, by the tables of thirty-ſix chances.

2 Sixes - - - -	1
2 Trois - - - -	1
2 Deuces - - - -	1
6 And 5 twice - - -	2
6 And 4 twice - - -	2
6 And 3 twice - - -	2
6 And 2 twice - - -	2
6 And 1 twice - - -	2
5 And 1 twice - - -	2
4 And 2 twice - - -	2
	17
Which deducted from - -	36
There remains - - -	19

By which it appears to be 19 to 17 againſt being hit upon a ſix.

The odds on the hits.

2 Love is about - -	5 to 2
2 to 1 is - - -	2 1
1 Love is - - -	3 2

Directions for the player to bear his men. If a player has taken up two of the adverſary's men, and happens to have two, three, or more points made in his own tables, he ſhould ſpread his men, that he either may take a new point in his tables, or be ready to hit the man which the adverſary may happen to enter. If he finds upon the adverſary's entering, that the game is upon a par, or that the advantage is on his own ſide, he ſhould take the adverſary's man up whenever he can, it being 25 to 11 that he is not hit: except when he is playing for a ſingle hit only; then, if playing the throw otherwiſe gives him a better chance for it, he ought to do it.

It being five to one againſt his being hit with double dice, he ſhould never be deterred from taking up any one man of the adverſary's.

If he has taken up one of the adverſary's men, and ſhould happen to have five points in his own tables, and forced to leave a blot out of his tables, he ſhould endeavour to leave it upon doublets preferable to any other chance, becauſe in that caſe the odds are 35 to one that he is not hit; whereas it is only 17 to one but he is hit upon any other chance.

When the adverſary is very forward, a player ſhould never move a man from his own quatre, trois, or deuce points, thinking to bear that man from the point where he put it, as nothing but high doublets can give him any chance for the hit. Inſtead of playing an ace or a deuce from any of thoſe points, he ſhould play them from his own ſize or higheſt points, ſo that throwing two fives, or two fours, his ſize and cinque points being eaſed, would be a conſiderable advantage to him;

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whereas had they been loaded, he muſt have been obliged to play otherwiſe.

It is the intereſt of the adverſary to take up the player as ſoon as he enters. The blot ſhould be left upon the adverſary's loweſt point; that is to ſay, upon his deuce point, rather than upon his trois point; or upon his trois point rather than his quatre point; or upon his quatre point preferable to his cinque point, for a reaſon before mentioned; all the men the adverſary plays upon his trois, or his deuce points, are deemed loſt, being greatly out of play; ſo that thoſe men not having it in their power to make his cinque point, and his game being crowded in one place and open in another, the adverſary muſt be greatly annoyed by the player.

If the player has two of the adverſary's men in his tables, he has a better chance for a hit than if he had more, provided his game is forwarder than that of his antagoniſt's; for if he had three or more of the adverſary's men in his tables, he would ſtand a worſe chance to be hit.

When a player is running to ſave the gammon, if he ſhould have two men upon his ace point, and ſeveral men abroad, although he ſhould loſe one point or two in putting his men into his tables, it is his intereſt to leave a man upon the adverſary's ace point, becauſe it will prevent his adverſary from bearing his men to the greateſt advantage, and at the ſame time the player will have a chance of his adverſary's making a blot, which he may chance to hit. However, if a player finds upon a throw, that he has a probability of ſaving his gammon, he ſhould never wait for a blot, as the odds are greatly againſt his hitting it, but ſhould embrace that opportunity.

How to calculate the odds of ſaving or winning the gammon. Suppoſe the adverſary has ſo many men abroad as require three throws to put them into his tables, and at the ſame time that the player's tables are made up, and that he has taken up one of the adverſary's men; in this caſe, it is about an equal wager that the adverſary is gammoned. For in all probability the player has bore two men before he opens his tables, and when he bears the third man, he will be obliged to open his ſize or cinque point. It is then probable, that the adverſary is obliged to throw twice before he enters his men in the player's tables, twice more before he puts that man into his own tables, and three throws more to put the men which are abroad into his own tables, in all ſeven throws. Now the player having 12 men to bear, he may be forced to make an ace or a deuce twice before he can bear all his men, and conſequently will require ſeven throws in bearing them; ſo that, upon the whole, it is about equal whether the adverſary is gammoned or not.

Suppoſe a player has three men upon his adverſary's ace point and five points in his own tables, and that the adverſary has all his men in his tables, three upon each of his five higheſt points, Has the player a probability of gammoning his adverſary or not?

	Points.
For bearing three men from his 6th point is	18
From his 5th point	15
	—
Carried forward	33
From his 4th point	12
From his 3d point	9
From his 2d point	6
In all	60
Bringing his three men from the adverſary's ace point to his ſize point in his own tables, being 18 points each, and making together.	54
There muſt remain	6

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It is plain from this calculation, that the player has much the beſt of the probability of the gammon, excluſive of one or more blots which the adverſary is liable to make in bearing his men, ſuppoſing at the ſame time the throws to be upon an equality.

Suppoſe two blots are left, either of which cannot be hit but by double dice; one muſt be hit by throwing eight and the other by throwing nine; ſo that the adverſary has only one die to hit either of them. What are the odds of hitting either of them? The chances of two dice being in all 36

The chances to hit 8 are 6 and 2 twice	2
5 and 3 twice	2
2 Deuces	1
2 Fours	1
The chances to hit 9 are 6 and 3 twice	2
5 And 4 twice	2
2 Trois	1
For hitting, in all	11
Chances for not hitting, remain	25

So that the odds are 25 to 11 againſt hitting either of theſe blots.

This method may be taken to find out the odds of hitting three, four, or five blots upon double dice; or blots made upon double and ſingle dice at the ſame time. After knowing how many chances there are to hit any of thoſe blots, they muſt be added all together, and then ſubtract from the number 36, which are the chances of the two dice, and the queſtion is ſolved.

A critical caſe for a Back-game. Suppoſe the foregame to be played by A, and that all his men are placed as uſual; B has fourteen of his men placed upon his adverſary's ace point, and one upon his adverſary's deuce point, and B is to throw. Who has the beſt of the hit?—*Anſwer:* A has the beſt of it, gold to ſilver: becauſe, if B does not throw an ace to take his adverſary's deuce point, which is 25 to 11 againſt him, A will take up B's men in his tables, either ſingly or to make points; and then if B ſecures either A's deuce or trois point, A will put as many men down as poſſible, in order to hit, and thereby get a back-game. It is evident that the back-game is very powerful; conſequently, whoever practiſes it muſt become a greater proficient at the game than he could by any other means.

Another critical caſe. Suppoſe A to have five men placed upon his ſize point, as many upon his quatre point, and the ſame number upon his deuce point, all in his own tables. At the ſame time, let us ſuppoſe B to have three men placed upon A's ace point, as many upon A's trois point, and the ſame number upon

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upon A's cinque point, in his own tables, and three men placed as uſual out of his tables. Who has the beſt of the hit?—*Anſwer:* The game is equal, till B has gained his cinque and quatre points in his own tables; which if he can effect, and by playing two men from A's cinque point, in order to force his adverſary to blot by throwing an ace, which ſhould B hit, he will have the beſt of the hit.

A caſe of curioſity and inſtruction; in which is ſhewn the probability of making the hit laſt by one of the players for many hours, although they ſhould both play as faſt as uſual.—Suppoſe B to have bore 13 men, and that A has his fifteen men in B's tables, *viz.* three men upon his ſize point, as many upon his cinque point, three upon his quatre point, the ſame number upon his trois point, two upon his deuce point, and one upon his ace point. A in this ſituation can prolong it, as aforeſaid, by bringing his 15 men home, always ſecuring ſix cloſe points till B has entered his two men, and brought them upon any certain point; as ſoon as B has gained that point, A will open an ace, deuce, or trois point, or all of them; which done B hits one of them, and A taking care to have two or three men in B's tables, is ready to hit that man; and alſo he being certain of taking up the other man, has it in his power to prolong the hit almoſt to any length, provided he takes care not to open ſuch points as two fours, two fives, or two ſixes, but always to open the ace, deuce, or trois points, for B to hit him.

A critical game to play. Suppoſe A and B place their men for a hit in the following manner: A to have three men upon the ſize point in his own tables, three men out of his tables upon the uſual point, and nine men upon his adverſary's ace, deuce, and trois points; that is, three upon each; and ſuppoſe B's men to be placed in his own and his adverſary's tables in the ſame order. So ſituated, the beſt player ſhould win the hit. The game being ſo equal, that in this caſe the dice ſhould be thrown for. Now if A throws firſt, he ſhould endeavour to gain his adverſary's cinque point: this being done, he ſhould lay as many blots as poſſible, to tempt B to hit him, as it puts him backward, and A thereby gains an advantage. A ſhould always endeavour to have three men upon each of his adverſary's ace and deuce points; becauſe when B makes a blot, theſe points will remain ſecure, and when A has bore five, ſix, or more men, A yet may ſecure ſix cloſe points out of his tables, in order to prevent B from getting his man home, at which time he ſhould calculate who has the beſt of the hit. If he finds that B is foremoſt, he ſhould then try to lay ſuch blots as may be taken up by his adverſary, that he may have a chance of taking up another man, in caſe B ſhould happen to have a blot at home.

Laws of Backgammon. 1. If a man is taken from any point, it muſt be played; if two men are taken from it, they alſo muſt be played. 2. A man is not ſuppoſed to be played till it is placed upon a point and quitted. 3. If a player has only fourteen men in play, there is no penalty inflicted, becauſe by his playing with a leſſer number than he is intitled to, he plays to a diſadvantage for want of the deficient man to make up his tables. 4. If he bears any number of men before he has entered a man taken up, and which of courſe he was obliged to enter, ſuch men ſo borne muſt be entered again in the adverſary's tables as well as the man taken up. 5. If he has miſtaken his throw and played it, and his adverſary has thrown, it is not in the choice of either of the players to alter it, unleſs they both agree ſo to do.

Back-Painting, Back-Staff.

Back-Painting, the method of painting mezzotinto prints, paſted on glaſs, with oil-colours. See MEZZOTINTO.

The art conſiſts chiefly in laying the print upon a piece of crown-glaſs, of ſuch a ſize as fits the print.

In order to do this, take your print, and lay it in clean water for two days and two nights, if the print be on very ſtrong, cloſe, and hard gummed paper; but if upon an open, ſoft, ſpungy paper, two hours will ſometimes ſuffice, or more, according as the paper is.

The paper or picture having been ſufficiently ſoaked, take it out and lay it upon two ſheets of paper, and cover it with two more; and let it lie there a little to ſuck out the moiſture.

In the mean time, take the glaſs the picture is to be put upon, and ſet it near the fire to warm; take Straſburg turpentine, warm it over the fire till it is grown fluid, then with a hog's-hair bruſh ſpread the turpentine very ſmoothly and evenly on the glaſs.

When this has been done, take the mezzotinto print from between the papers, and lay it upon the glaſs; beginning firſt at one end, rubbing it down gently as you go on, till it lie cloſe, and there be no wind bladders between.

Then, with your fingers, rub or roll off the paper from the back ſide of the print, till it looks black, *i. e.* till you can ſee nothing but the print, like a thin film, left upon the glaſs, and ſet it by to dry.

When it is dry, varniſh it over with ſome white tranſparent varniſh, that the print may be ſeen through it; and then it is fit for painting.

The utmoſt care will be neceſſary in rubbing or rolling the paper of the print, ſo as not to tear it, eſpecially in the light parts.

You may, inſtead of ſoaking your prints two days and two nights, roll them up and boil them for about two hours, more or leſs, according to the quality of the paper, in water; and that will render it as fit for rubbing, rolling, or peeling, as the other way.

This being done, and your oil-colours prepared, ground very fine, and tempered very ſtiff, lay on the back-ſide of the tranſparent prints ſuch colours as each particular part requires; letting the maſter-lines of the print ſtill guide your pencil, and ſo each particular colour will lie fair to the eye on the other ſide of the glaſs, and look almoſt as well as a painted piece, if it be done neatly.

The ſhadows of the print are generally ſufficient for the ſhadow of every colour; but if you have a mind to give a ſhadow by your pencil, then let the ſhadows be laid on firſt, and the other colours afterward.

In laying on colours in this kind of back-painting, you need not be curious as to the laying them on ſmooth. This is not at all requiſite here, where the chief aim is only to have the colours appear well on the fore ſide of the print; and therefore the only care to be uſed in this work, is to lay the colours on thick enough, that its body may ſtrike the colour of it plainly through the glaſs.

Back-Staff, a name formerly given to a ſea-qua-

Back-Stays. Backereel.

drant invented by Captain Davis: becauſe the back of the artiſt is turned towards the ſun at the time of obſervation. See QUADRANT.

BACK-Stays, of a ſhip, are ropes belonging to the main-maſt and fore-maſt, and the maſts belonging to them; ſerving to keep them from pitching forwards or overboard.

BACK-Tack, in Scots law: When a wadſetter, inſtead of poſſeſſing the wadſet-lands, grants a tack thereof to the reverſer for payment of a certain ſum in name of tack-duty, that tack is called a *back-tack*.

BACK-Worm. See FILANDERS.

BACKER, or BAKKER, (Jaques), a painter of hiſtory, was born at Antwerp in 1530; and learned the principles of painting from his father, who was an artiſt very knowing in his profeſſion, though his works were in no great eſtimation. After the death of his father, he lived in the houſe of Jacopo Palermo, a dealer in pictures, who avariciouſly took care to keep him inceſſantly employed, and ſent his paintings to Paris to be diſpoſed of, where they happened to be exceedingly admired. The judicious were very eager to purchaſe them; and though the tranſactor ſold them at a great price, yet the poor artiſt was not proportionably rewarded, but continued in the ſame obſcure and depreſſed condition. His merit, indeed, was univerſally allowed, but his name, and the narrowneſs of his circumſtances, were as univerſally unknown. He had a clean light manner of pencilling, and a tint of colour that was extremely agreeable.—He died in 1560.

BACKER, or BAKKER, (Jacob), painter of portrait and hiſtory, was born at Harlingen in 1609, but ſpent the greateſt part of his life at Amſterdam; and by all the writers on this ſubject, he is mentioned as an extraordinary painter, particularly of portraits, which he executed with ſtrength, ſpirit, and a graceful reſemblance. He was remarkable for an uncommon readineſs of hand and freedom of pencil; and his incredible expedition in his manner of painting, appeared even in one portrait of a lady from Haerlem, that he painted at half length, which was begun and finiſhed in one day, though he adorned the figure with rich drapery and ſeveral ornamental jewels. He alſo painted hiſtorical ſubjects with good ſucceſs; and in that ſtyle there is a fine picture of Cimon and Iphigenia, which is accounted by the connoiſſeurs an excellent performance. In deſigning academy figures his expreſſion was ſo juſt, and his outline ſo correct, that he obtained the prize from all his competitors; and his works are ſtill bought up at very high prices in the Low Countries. In the collection of the Elector Palatine there is an excellent head of Brouwer, painted by this maſter; and in the Carmelites church at Antwerp is preſerved a capital picture of the Laſt Judgment, which is well deſigned and well coloured. He died in 1651.

BACKEREEL, called BACQUERELLI, (William) a painter of hiſtory, was born at Antwerp, and was a diſciple of Rubens, at the ſame time that Vandyck was educated in that ſchool. When each of them quitted that maſter and commenced painters, Backereel was very little inferior to Vandyck, if not nearly his equal. And this may be manifeſtly ſeen in the works of the former, which are in the church of the Auguſtin Monks at Antwerp; where thoſe two great artiſts painted in competition, and both were praiſed for their merit in their different ways; but the ſuperiority was never determined in favour either of the one or the other. He had likewiſe a good taſte for poetry; but, by exerciſing that talent too freely, in writing ſatires againſt the Jeſuits, theſe eccleſiaſtics purſued him with unremitted revenge, till they compelled him to fly from Antwerp; and by that means deprived his own country of ſuch paintings as would have contributed to its perpetual honour.—Sandrart took notice, that in his time there were ſeven or eight painters, who were very eminent, of the name of Backereel, in Italy and the Low Countries. Backhuyſen.

BACKHUYSEN (Ludolph), an eminent painter, was born at Embden in 1631, and received his earlieſt inſtruction from Albert Van Everdingen; but acquired his principal knowledge by frequenting the painting rooms of different great maſters, and obſerving their various methods of touching and colouring. One of thoſe maſters was Henry Dubbels, whoſe underſtanding in his art was very extenſive; and he was as remarkably communicative of his knowledge to others. From him Backhuyſen obtained more real benefit than from all the painters of his time, either by ſtudying their works, or perſonally converſing with them. His ſubjects were ſea-pieces, ſhips, and ſea-ports. He had not practiſed very long when he became the object of general admiration; ſo that even his drawings were ſought after, and ſeveral of them were bought up at 100 florins a-piece. It was obſerved of him, that while he was painting, he would not ſuffer even his moſt intimate friends to have acceſs to him, leſt his fancy might be diſturbed, and the ideas he had formed in his mind be interrupted. He ſtudied nature attentively in all her forms; in gales, calms, ſtorms, clouds, rocks, ſkies, lights, and ſhadows; and he expreſſed every ſubject with ſo ſweet a pencil, and ſuch tranſparence and luſtre, as placed him above all the artiſts of his time in that ſtyle, except the younger Vandervelde, who is deſervedly eſteemed the firſt in that manner of painting. It was a frequent cuſtom with Backhuyſen, whenever he could procure reſolute mariners, to go to ſea in a ſtorm, in order to ſtore his mind with grand images, directly copied from nature, of ſuch ſcenes as would have filled any other head and heart with terror and diſmay; and the moment he landed, he always impatiently ran to his palette to ſecure theſe incidents, of which the traces might by delay be obliterated.—He perfectly underſtood the management of the Chiaro-Scuro, and by his ſkill in that part of his art, he gave uncommon force and beauty to his objects. He obſerved ſtrictly the truth of perſpective, in the diſtances of his veſſels, the receding of the grounds on the ſhores, and the different buildings which he deſcribed in the ſea-ports; whether they were the reſult of his own imagination, or ſketched, as he uſually did, after nature. His works may eaſily be diſtinguiſhed by an obſervant eye, from the freedom and neatneſs of his touch; from the clearneſs, and natural agitation or quieſcence of the water; from a peculiar tint in his clouds and ſkies; and alſo from the exact proportions of his ſhips, and the gracefulneſs of their poſition. For the Burgomaſters of Amſterdam he painted a large picture, with a multitude of veſſels, and a view of the

city

Backing ‖ Bacon.

city at a diſtance, for which they gave him thirteen hundred guilders, and a conſiderable preſent; which picture they afterwards preſented to the king of France, who placed it in the Louvre. No painter was ever more honoured by the viſits of the kings and princes than Backhuyſen; the king of Pruſſia was one of the number; and the Czar Peter the Great took delight to ſee him paint, and often endeavoured to draw after veſſels which he had deſigned. He was remarkably aſſiduous, and yet it ſeems aſtoniſhing to conſider the number of pictures which he finiſhed, and the exquiſite manner in which they are painted. He died in 1709.

BACKING, in horſemanſhip. See HORSEMANSHIP.

BACKING *the Sails*, in navigation; to arrange them in a ſituation that will force the ſhip to retreat, or move backwards. This is, however, only done in narrow channels, when a ſhip is carried along ſidewiſe by the tide or current, and wants to avoid any thing that may interrupt her progreſs, as ſhoals, veſſels at anchor, &c. or in the line of battle, when a ſhip wants to be immediately oppoſite to another with which ſhe is engaged.

BACKS, among dealers in leather, denote the thickeſt and beſt tanned hides, uſed chiefly for ſoles of ſhoes.

BACKS, in brewing and diſtilling. See BAC.

BACULARIUS, in writers of the middle age, an eccleſiaſtical apparitor, or verger; who carries a ſtaff, *baculus*, in his hand, as an enſign of his office.

BACON, ſwines fleſh ſalted, and dried in the chimney.—Old hiſtorians and law-writers ſpeak of the *ſervice of the bacon*, a cuſtom in the manor of Whichenacre in Staffordſhire, and priory of Dunmore in Eſſex; in the former of which places, by an ancient grant of the lord, a flitch of bacon, with half a quarter of wheat, was to be given to every married couple who could ſwear, that, having been married a year and a day, they would never within that time have once exchanged their mate for any other perſon on earth, however richer, fairer, or the like. But they were to bring two of their neighbours to ſwear with them that they believed they ſwore the truth. On this the lord of another neighbouring manor, of Rudlow, was to find a horſe ſaddled, and a ſack to carry the bounty in, with drums and trumpets, as far as a day's journey out of the manor: all the tenants of the manor being ſummoned to attend, and pay ſervice to the bacon. The bacon of Dunmore, firſt erected under Henry III. was on much the ſame footing; only the tenor of the oath was, that the parties had never once repented, or wiſhed themſelves unmarried again.

BACON (Roger), a Franciſcan friar of amazing genius and learning, was born near Ilcheſter in Somerſetſhire, in the year 1214. He began his ſtudies at Oxford; but in what ſchool, or college is uncertain. Thence he removed to the univerſity of Paris, which, in thoſe times, was eſteemed the centre of literature. Here, we are told, he made ſo rapid a progreſs in the ſciences, that he was eſteemed the glory of that univerſity, and was much careſſed by ſeveral of his countrymen, particularly by Robert Grouthead, afterwards biſhop of Lincoln, his ſingular friend and patron. About the year 1240, he returned to Oxford; and aſſuming the Franciſcan habit, proſecuted his favourite ſtudy of experimental philoſophy, with unremitting ardor and aſſiduity. In this purſuit, in experiments, inſtruments, and in ſcarce books, he tells us, he ſpent, in the ſpace of 20 years, no leſs than L. 2000; which it ſeems, was given him by ſome of the heads of the univerſity, to enable him to proſecute his noble inquiries. By ſuch extraordinary talents, and aſtoniſhing progreſs in ſciences, which, in that ignorant age, were totally unknown to the reſt of mankind, whilſt they raiſed the admiration of the more intelligent few, could not fail to excite the envy and malice of his illiterate fraternity; who found no difficulty of poſſeſſing the vulgar with the notion of Bacon's dealing with the devil. Under this pretence, he was reſtrained from reading lectures; his writings were confined to his convent; and finally, in 1278, he himſelf was impriſoned in his cell. At this time he was 64 years of age. Nevertheleſs, being permitted the uſe of his books, he went on in the rational purſuit of knowledge, corrected his former labours, and wrote ſeveral curious pieces. When he had been 10 years in confinement, Jerom de Aſcoli being elected pope, Bacon ſolicited his holineſs to be releaſed; in which, it ſeems, he did not immediately ſucceed. However, towards the latter end of that pope's reign, he obtained his liberty, and ſpent the remainder of his life in the college of his order, where he died in the year 1294, in the 80th year of his age, and was buried in the Franciſcan church. Such are the few particulars which the moſt diligent reſearches have been able to diſcover concerning this very great man; who, like a ſingle bright ſtar in a dark hemiſphere, ſhone forth the glory of his country, and the pride of human nature. His works are, 1. *Epiſtola fratris Rogeri Baconis de ſecretis operibus artis et naturæ, et de nullitate magiæ.* Paris, 1542, 4to. Baſil, 1593, 8vo. 2. *Opus majus.* Lond. 1733, fol. publiſhed by Dr Jebb. 3. *Theſaurus chemicus.* Francf. 1603, 1620. This was probably the editor's title; but it contains ſeveral of our author's treatiſes on this ſubject. Theſe printed works of Bacon contain a conſiderable number of eſſays, which, in the catalogue of his writings by Bale, Pits, &c. have been conſidered as diſtinct books; but there remain in different libraries ſeveral manuſcripts not yet publiſhed. By an attentive peruſal of his works, the reader will be aſtoniſhed to find, that this great luminary of the 13th century was a great linguiſt and a ſkilful grammarian; that he was well verſed in the theory and practice of perſpective; that he underſtood the uſe of convex and concave glaſſes, and the art of making them; that the *camera obſcura*, burning-glaſſes, and the power of the teleſcope, were known to him; that he was well verſed in geography and aſtronomy; that he knew the great error in the kalendar, aſſigned the cauſe, and propoſed the remedy; that he underſtood chronology well; that he was an adept in chemiſtry, and was really the inventor of gun-powder; that he poſſeſſed great knowledge in the medical art; that he was an able mathematician, logician, metaphyſician, and theologiſt.

Bacon.

BACON (Sir Nicholas), lord keeper of the great ſeal in the reign of Queen Elizabeth, was born at Chiſlehurſt, in Kent, in 1510, and educated at the univerſity of Cambridge; after which he travelled into France, and made ſome ſtay at Paris. On his return, he ſettled in Gray's-inn, and applied himſelf with ſuch aſſiduity to the ſtudy of the law, that he quickly diſtinguiſhed him-

Bacon. himſelf ſo, that on the diſſolution of the monaſtery of St Edmund's Bury, in Suffolk, he had a grant from King Henry VIII. in the 36th year of his reign, of ſeveral manors. In the 38th of the ſame king, he was promoted to the office of attorney in the court of Wards, which was a place both of honour and profit. In this office he was continued by King Edward VI.; and in 1552 he was elected treaſurer of Gray's-inn. His great moderation and conſummate prudence preſerved him through the dangerous reign of Queen Mary. In the very dawn of that of Elizabeth he was knighted; and on the 22d of December 1558, the great ſeal of England, being taken from Nicholas Heath archbiſhop of York, was delivered to him with the title of *lord keeper*, and he was alſo made one of the Queen's privy council. He had a conſiderable ſhare in the ſettling of religion: as a ſtateſman, he was remarkable for a clear head and deep counſels: but his great parts and high preferment were far from raiſing him in his own opinion, as appears from the modeſt anſwer he gave Queen Elizabeth, when ſhe told him his houſe at Redgrave was too little for him: "Not ſo, madam, (returned he); but your majeſty has made me too great for my houſe." After having had the great ſeal more than 20 years, this able ſtateſman and faithful counſellor was ſuddenly removed from this life, as Mr Mallet informs us, by the following accident: he was under the hands of the barber, and thinking the weather warm, had ordered a window before him to be thrown open, but fell aſleep as the current of freſh air was blowing in upon him, and awakened ſome time after diſtempered all over. He was immediately removed into his bed-chamber, where he died a few days after, on the 26th of February 1578-9, equally lamented by the Queen and her ſubjects. He was buried in St Paul's, where a monument was erected to him, which was deſtroyed by the fire in London in 1666. Mr Granger obſerves, that he was the firſt lord keeper that ranked as lord chancellor; and that he had much of that penetrating genius, ſolidity, and judgment, perſuaſive eloquence, and comprehenſive knowledge of law and equity, which afterwards ſhone forth with ſo great a luſtre in his ſon, who was as much inferior to his father in point of prudence and integrity as his father was to him in literary accompliſhments.

Bacon (Francis), lord high chancellor of England under king James I. was ſon of Sir Nicholas Bacon lord keeper of the great ſeal in the reign of Queen Elizabeth, by Anne daughter of Sir Anthony Cook, eminent for her ſkill in the Latin and Greek tongues. He was born in 1560; and ſhowed ſuch marks of genius, that he was particularly taken notice of by Queen Elizabeth when very young. He was educated at Trinity-college, Cambridge; and made ſuch incredible progreſs in his ſtudies, that, before he was 16, he had not only run through the whole circle of the liberal arts as they were then taught, but began to perceive thoſe imperfections in the reigning philoſophy, which he afterwards ſo effectually expoſed, and thereby not only overturned that tyranny which prevented the progreſs of true knowledge, but laid the foundation of that free and uſeful philoſophy which has ſince opened a way to ſo many glorious diſcoveries. On his leaving the univerſity, his father ſent him to France; where, before he was 19 years of age, he wrote a general view of the ſtate of Europe; but Sir Nicholas dying, he was obliged ſuddenly to return to England; when he applied himſelf to the ſtudy of the common law, at Gray's-inn. At this period the famous Earl of Eſſex, who could diſtinguiſh merit, and who paſſionately loved it, entered into an intimate friendſhip with him; zealouſly attempted, though without ſucceſs, to procure him the office of queen's ſolicitor; and, in order to comfort his friend under the diſappointment, conferred on him a preſent of land to the value of 1800l. Bacon, notwithſtanding the friendſhip of ſo great a perſon; notwithſtanding the number and power of his own relations; and, above all, notwithſtanding the early prepoſſeſſion of her majeſty in his favour; met with many obſtacles to his preferment during her reign. In particular, his enemies repreſented him as a ſpeculative man, whoſe head was filled with philoſophical notions, and therefore more likely to perplex than forward public buſineſs. It was not without great difficulty that lord treaſurer Burleigh obtained for him the reverſion of regiſter to the ſtar-chamber, worth about 1600l. a-year, which place fell to him about 20 years after. Neither did he obtain any other preferment all this reign; though if obedience to a ſovereign in what muſt be the moſt diſagreeable of all offices, viz. the caſting reflections on a deceaſed friend, intitled him, he might have claimed it. The people were ſo clamorous even againſt the Queen herſelf on the death of Eſſex, that it was thought neceſſary to vindicate the conduct of the adminiſtration. This was aſſigned to Bacon, which brought on him univerſal cenſure, nay his very life was threatened. Upon the acceſſion of King James, he was ſoon raiſed to conſiderable honours; and wrote in favour of the union of the two kingdoms of Scotland and England, which the King ſo paſſionately deſired. In 1616, he was ſworn of the privy-council. He then applied himſelf to the reducing and recompoſing the laws of England. He diſtinguiſhed himſelf, when attorney-general, by his endeavours to reſtrain the cuſtom of duels, then very frequent. In 1617, he was appointed lord keeper of the great ſeal. In 1618, he was made lord chancellor of England, and created Lord Verulam. In the midſt of theſe honours and applauſes, and multiplicity of buſineſs, he forgot not his philoſophy, but in 1620 publiſhed his great work intitled *Novum Organum*. We find by ſeveral letters of his, that he thought convening of parliaments was the beſt expedient for the king and people. In 1621, he was advanced to the dignity of Viſcount St Albans, and appeared with the greateſt ſplendour at the opening of the ſeſſion of parliament. But he was ſoon after ſurpriſed with a melancholy reverſe of fortune. For, about the 12th of March, a committee of the houſe of commons was appointed to inſpect the abuſes of the courts of juſtice. The firſt thing they fell upon was bribery and corruption, of which the lord chancellor was accuſed. For that very year complaints being made to the houſe of commons of his lordſhip's having received bribes, thoſe complaints were ſent up to the houſe of lords; and new ones being daily made of a like nature, things ſoon grew too high to be got over. The King found it was impoſſible to ſave both his chancellor, who was openly accuſed of corruption, and Buckingham his favourite, who was ſecretly and therefore more dangerouſly attacked as the encourager of whatever

Bacon. whatever was deemed moſt illegal and oppreſſive: he therefore forced the former to abandon his defence, giving him poſitive advice to ſubmit himſelf to his peers, and promiſing upon his princely word to ſcreen him in the laſt determination, or, if that could not be, to reward him afterwards with ample retribution of favour. The chancellor, though he foreſaw his approaching ruin if he did not plead for himſelf, reſolved to obey; and the houſe of peers, on the 3d of May 1621, gave judgment againſt him, "That he ſhould be fined 40,000l. and remain priſoner in the tower during the king's pleaſure; that he ſhould for ever be incapable of any office, place, or employment, in the ſtate or commonwealth; and that he ſhould never ſit in parliament, or come within the verge of the court." The fault which, next to his ingratitude to Eſſex, thus tarniſhed the glory of this illuſtrious man, is ſaid to have principally proceeded from his indulgence to his ſervants, who made a corrupt uſe of it. One day, during his trial, paſſing through a room where ſeveral of his domeſtics were ſitting, upon their riſing up to ſalute him, he ſaid, "Sit down, my maſters; your riſe hath been my fall." *Stephens*, p. 54. And we are told by Ruſhworth in his hiſtorical collections, "That he treaſured up nothing for himſelf or family, but was over-indulgent to his ſervants, and connived at their takings, and their ways betrayed him to that error; they were profuſe and expenſive, and had at their command whatever he was maſter of. The gifts taken were for the moſt part for interlocutory orders; his decrees were generally made with ſo much equity, that though gifts rendered him ſuſpected for injuſtice, yet never any decree made by him was reverſed as unjuſt." It was peculiar to this great man (ſay the authors of the Biogr. Brit.) to have nothing narrow and ſelfiſh in his compoſition: he gave away without concern whatever he poſſeſſed; and believing other men of the ſame mould, he received with as little conſideration. He retired, after a ſhort impriſonment, from the engagements of an active life, to which he had been called much againſt his genius, to the ſhade of a contemplative one, which he had always loved. The King remitted his fine, and he was ſummoned to parliament in the firſt year of King Charles I. It appears from the works compoſed during his retirement, that his thoughts were ſtill free, vigorous, and noble. The laſt five years of his life he devoted wholly to his ſtudies. In his receſs he compoſed the greateſt part of his Engliſh and Latin works. He expired on the 9th of April, 1626; and was buried in St Michael's church at St Albans, according to the direction of his laſt will, where a monument of white marble was erected to him by Sir Thomas Meautys formerly his ſecretary, and afterward clerk of the privy council under two kings. A complete edition of this great man's works was publiſhed at London in the year 1740.—Addiſon has ſaid of him, That he had the ſound, diſtinct, comprehenſive knowledge of Ariſtotle, with all the beautiful light graces and embelliſhments of Cicero. The honourable Mr Walpole calls him the *Prophet of Arts* which Newton was afterwards to reveal; and adds, that his genius and his works will be univerſally admired as long as ſcience exiſts. "As long as ingratitude and adulation are deſpicable, ſo long ſhall we lament the depravity of this great man's heart. Alas! that he who could command immortal fame, ſhould have ſtooped to the little ambition of power."

Bacon ‖ Bactria.

BACON (Sir Nathaniel), knight of the bath, and an excellent painter, was a younger ſon of the lord keeper, and half brother to the great Sir Francis. He travelled into Italy, and ſtudied painting there; but his manner and colouring approaches nearer to the ſtyle of the Flemiſh ſchool. Mr Walpole obſerves, that at Culford, where he lived, are preſerved ſome of his works; and at Gorhambury, his father's ſeat, is a large picture by him in oil, of a cook-maid, with a dead fowl, admirably painted, with great nature, neatneſs, and luſtre of colouring. In the ſame houſe is a whole length of him, by himſelf, drawing on a paper, his ſword and pallet hung up, and a half length of his mother by him.

BACONTHORP (John), called the *reſolute doctor*, a learned monk, was born towards the end of the 13th century, at Baconthorp a village in Norfolk. He ſpent the early part of his life in the convent of Blackney, near Walſingham in the ſame county; whence he removed to Oxford, and from thence to Paris; where being diſtinguiſhed for his learning, he obtained degrees in divinity and laws, and was eſteemed the principal of Averroiſts*. In 1329 he returned to England, and was immediately choſen twelfth provincial of the Engliſh Carmelites. In 1333 he was ſent for to Rome; where, we are told, he firſt maintained the pope's ſovereign authority in caſes of divorce, but that he afterwards retracted his opinion. He died in London in the year 1346. Leland, Bale, and Pits, unanimouſly give him the character of a monk of genius and learning. He wrote, 1. *Commentaria ſeu quæſtiones ſuper quatuor libros ſententiarum*; and, 2. *Compendium legis Chriſti, et quodlibeta*: both which underwent ſeveral editions at Paris, Milan, and Cremona. Leland, Bale, and Pits, mention a number of his works never publiſhed.

* See *Averroes*.

BACTRIA, or BACTRIANA, now *Choraſſan* or *Khoraſan*, an ancient kingdom of Aſia, bounded on the weſt by Margiana, on the north by the river Oxus, on the ſouth by mount Paropiſmus, and on the eaſt by the Aſiatic Scythia and the country of the Maſſagetæ. It was a large, fruitful, and well-peopled country, containing according to Ammianus Marcellinus 1000 cities, though of theſe only a few are particularly mentioned by hiſtorians, of which that formerly called *Maracanda*, now *Samarcand*, is the moſt conſiderable.

Of the hiſtory of this country we know but little. Authors agree that it was ſubdued firſt by the Aſſyrians, afterwards by Cyrus, and then by Alexander the Great. Afterwards it remained ſubject to Seleucus Nicator and his ſucceſſors till the time of Antiochus Theos; when Theodotus, from governor of that province, became king, and ſtrengthened himſelf ſo effectually in his kingdom, while Antiochus was engaged in a war with Ptolemy Philadelphus king of Egypt, that he could never afterwards diſpoſſeſs him of his acquiſitions. His poſterity continued to enjoy the kingdom for ſome time, till they were driven out by the Scythians, who reigned in Bactria at the time of Adrian, Antoninus Pius, &c. The Scythians were in their turn driven out by the Huns or Turks, and theſe often conquered by the Saracens and Tartars; nevertheleſs

Baſtroperata. | Badajoz.

theleſs they continued in poſſeſſion of this country in the time of Ladiſlaus IV. king of Hungary.

In early times the Bactrians differed little in their manners from the Nomades; and being near neighbours of the Scythians, who were a very warlike people, the Bactrian ſoldiers were reckoned the beſt in the world. Their appearance was very ſavage; being of an enormous ſtature, having a terrible aſpect, rough beards, and long hair hanging down their ſhoulders. Some authors aſſert that they kept dogs on purpoſe to devour ſuch as arrived at extreme old age, or who were exhauſted by long ſickneſs. They add, that for all their fierceneſs, the Bactrian huſbands were ſuch dupes to their wives, that they durſt not complain of them even for conjugal infidelity, to which it ſeems the latter were very much addicted.

BACTROPERATA, an ancient appellation given to philoſophers by way of contempt, denoting a man with a ſtaff and a budget.

We ſuppoſe it is of the ſame people that Pauchaſias Radbertus ſpeaks under the corrupt name of *Baccoperitæ*, or *Bacchionitæ*, whom he deſcribes as philoſophers who had ſo great a contempt for all earthly things, that they kept nothing but a diſh to drink out of; and that one of this order ſeeing a peaſant ſcooping up the water in his hand, threw away the cup as a ſuperfluity: which is nothing but the old ſtory of Diogenes the cynic.

BACULE, in fortification, a kind of portcullis, or gate, made like a pit-fall with a counterpoiſe, and ſupported by two great ſtakes. It is uſually made before the corpade-guard, not far from the gate of a place.

BACULOMETRY, the art of meaſuring acceſſible or inacceſſible heights, by the help of one or more baculi, ſtaves, or rods. See GEOMETRY.

BACURIUS, or BATURIUS, king of the Iberians, a people on the ſide of the Caſpian ſea. One day being a hunting, he loſt ſight of his company, through a great ſtorm and ſudden darkneſs; upon which he vowed to the God of his Chriſtian ſlave, that if he were delivered he would worſhip him alone: the day breaking up immediately, he made good his promiſe, and became the apoſtle of his country.

BADAGSHAN, a very ancient city of Great Bukharia, in the province of Balkh, ſituated at the foot of thoſe high mountains which ſeparate Indoſtan from Great Tartary. The city is exceedingly ſtrong by its ſituation; and belongs to the khan of proper Bukharia, who uſes it as a kind of ſtate-priſon to ſecure thoſe he is jealous of. The town is not very big, but well built, and very populous. It ſtands on the north ſide of the river Amu, about 100 miles from its ſource, and is a great thoroughfare for the caravans deſigned for little Bukharia. The inhabitants are enriched by mines of gold, ſilver, and rubies, which are in the neighbourhood; and thoſe who live at the foot of the mountains gather a great quantity of gold and ſilver duſt brought down in the ſpring by torrents occaſioned by the melting of the ſnow on the top.

BADAJOZ, a large and ſtrong town, capital of Eſtremadura in Spain. It is ſeated on the river Guadiana, over which there is a fine bridge built by the Romans. On this bridge the Portugueſe were defeated in 1661, by Don John of Auſtria. W. Long. 7. 3. N. Lat. 38. 35.

Badelona | Baden.

BADELONA, a town of Catalonia in Spain, ſeated on the Mediterranean. Lord Peterborough landed here in 1704, when, with Charles then king of Spain, he laid ſiege to Barcelona, from which it is ten miles diſtant. E. Long. 2. 20. N. Lat. 41. 12.

BADEN (the diſtrict of), in Swiſſerland, has three cities, Baden, Keiſers-Stoul, and Klingnaw, beſides a town that paſſes for a city, namely, *Zurzach*. It is one of the fineſt countries in Swiſſerland; and is watered with three navigable rivers, the Limmet, Ruſs, and Are. The land is fertile in corn and fruit, and there are places on the ſides of the Limmet which produces wine. It maintains a communication between the cantons of Zurich and Bern, being ſeated between their north extremities. It extends on one ſide to the Are, as far as the place where it falls into the Rhine, and on the other ſide beyond the Rhine, where there are ſome villages which depend thereon. Moſt of the inhabitants are Papiſts. By the treaty of peace at the concluſion of the war which broke out in 1712 between the Proteſtant and Popiſh cantons, this country was yielded to the Proteſtant cantons of Zurich and Bern. Before, it was the property of the eight old cantons; however, as the canton of Glaris had taken no part in this war, by the conſent of both parties its right was ſtill continued.

BADEN, the capital of the above diſtrict, is an agreeable city, moderately large, ſeated on the ſide of the Limmet, in a plain flanked by two high hills, between which the river runs. This city owes its riſe to its baths, which were famous before the Chriſtian æra. Several monuments of antiquity have been found here from time to time, particularly in 1420. When they were opening the large ſpring of the baths, they found ſtatues of ſeveral heathen gods, made of alabaſter; Roman coins, made of bronze, of Auguſtus, Veſpaſian, Decius, &c.; and ſeveral medals of the Roman emperors, of gold, ſilver, copper, and bronze. There are two churchs in Baden; one of which is collegiate, and makes a good appearance; the other is a monaſtery of the Capuchins, near the town-houſe. This laſt building ſerves not only for the aſſemblies of their own council, but alſo for thoſe of the cantons. The diet aſſembles there in a handſome room made for that purpoſe; the deputies of Zurich ſit at the bottom behind a table, as the moſt honourable place; the ambaſſadors of foreign powers are ſeated on one ſide to the right, and the deputies of the other cantons are ranged on each ſide the room. The bailiff of Baden reſides in a caſtle at the end of a handſome wooden bridge, which is covered in. Before this caſtle there is a ſtone pillar, erected in honour of the emperor Trajan, who paved a road in this country 85 Italian miles in length. The inhabitants are rigid Roman catholics, and formerly behaved in a moſt inſolent manner to the Proteſtants, but they are now obliged by their maſters to be more ſubmiſſive. The baths which are on each ſide the river are a quarter of a league from the city. Joining to the ſmall baths there is a village, and to the large a town which may paſs for a ſecond Baden. It is ſeated on a hill, of which the aſcent is ſteep. There the baths are brought into inns and private houſes, by means

Baden, Badens.

means of pipes, which are about 60 in all. There are alſo public baths in the middle of the town, from a ſpring which riſes in the ſtreet, where the poor bathe *gratis*, but they are expoſed quite naked to all that paſs by. All the baths are hot, and one to ſo great a degree as to ſcald the hand; and they are impregnated with a great deal of ſulphur, with ſome alum and nitre. They are uſeful for drinking as well as bathing; and are ſaid to cure all diſeaſes from a cold cauſe, headachs, vertigos, &c. They ſtrengthen the ſenſes, cure diſeaſes of the breaſt and bowels, aſthmas, and obſtructions. They are peculiarly excellent for women's diſeaſes. E. Long. 8. 25. N. Lat. 47. 27.

BADEN (the Margravate of), in the circle of Swabia, in Germany, is bounded by the Palatinate of the Rhine, on the north; by the Black Foreſt, on the eaſt; by Swiſſerland, on the ſouth; and by the Rhine, which divides it from Alſace, on the eaſt: and is about 90 miles in length, from north to ſouth; but not above 20 in breadth, where it is wideſt. It is a very populous and fruitful country, abounding in corn and wine. Veniſon and wild fowl are ſo plentiful, that they are the common diet of the peaſants. The rivers that water this territory, are the Rhine, Ens, Wirmbs, and Phints, which yield plenty of fiſh. They feed their hogs with cheſnuts, which make the bacon excellent. They have free-ſtone for building, and marble of all colours. They have ſome agate, and great quantities of hemp and flax for exportation. The chief towns are Baden, Durlach, Stolhafen, Raſtadt, Gerſbach, Pforſheim, and Horchberg.

BADEN, the chief city of the above margravate, has a caſtle that ſtands on the top of a hill, which is the reſidence of a prince. The town is ſeated among hills, on rocky and uneven ground, which renders the ſtreets inconvenient and crooked. It is famous for its baths, the ſprings of which are ſaid to be above 300. Some of them are hot, and accounted to be very good in nervous caſes. They partake of ſalt, alum, and ſulphur. E. Long. 9. 24. N. Lat. 48. 50.

BADEN, a town of Germany, in the arch-duchy of Auſtria, ſeated on the Little Suechat, is a neat little walled town, ſtanding in a plain not far from a ridge of hills which run out from the mountain Cetius. It is much frequented by the people of Vienna, and the neighbouring parts, on account of its baths. The ſprings ſupply two convenient baths within the town, five without the walls, and one beyond the river. They are good for diſtempers of the head, the gout, dropſy, and moſt chronic diſeaſes. E. Long. 17. 10. N. Lat. 48. 0.

BADENOCH, the moſt eaſterly part of Inverneſsſhire, in Scotland, extending about 33 miles in length from eaſt to weſt, and 27 from north-eaſt to ſouth-weſt where broadeſt. It has no conſiderable town, and is very barren and hilly, but abounds with deer, and other kinds of game.

BADEN-WEILLER, a town of Germany, belonging to the lower Margravate of Baden. E. Long. 7. 50. N. Lat. 47. 55.

BADENS (Francis), hiſtorical and portrait painter, was born at Antwerp in 1571, and the firſt rudiments of the art were communicated to him by his father, who was but an ordinary artiſt. However, he viſited Rome, and ſeveral parts of Italy, and there formed a good taſte of deſign, and a manner exceedingly pleaſing. When he returned to his own country his merit procured for him great employment, and ſtill greater reputation, and he was uſually diſtinguiſhed by the name of the Italian painter. His touch was light and ſpirited, and his colouring warm; and he had the honour of being the firſt who introduced a good taſte of colouring among his countrymen. While his acknowledged merit was rewarded with every public teſtimony of eſteem and applauſe, unhappily he received an account of the death of his brother, who had been aſſaſſinated on a journey; and the intelligence affected him ſo violently, that it occaſioned his own death, to the inexpreſſible regret of every lover of the art, in 1603.

Badge, Badius.

BADGE, in naval architecture, ſignifies a ſort of ornament placed on the outſide of a ſmall ſhips, very near the ſtern, containing either a window for the convenience of the cabin, or a repreſentation of it. It is commonly decorated with marine figures, martial inſtruments, or ſuch like emblems.

BADGER, in zoology, the Engliſh name for a ſpecies of urſus. See URSUS.

BADGER, in old law-books, one that was licenſed to buy corn in one place and carry it to another to ſell, without incurring the puniſhment of an engroſſer.

BADIA, an ancient town of Bætica on the Anas; now ſuppoſed to be Badajoz on the Guadiana.

BADIAGA, in the materia medica, the name of a ſort of ſpongy plant, common in the ſhops in Moſcow, and ſome other northern kingdoms. The uſe of it is the taking away the livid marks from blows and bruiſes, which the powder of this plant is ſaid to do in a night's time.

BADIANE, or BANDIAN, the ſeed of a tree which grows in China, and ſmells like aniſe-ſeed. The Chineſe, and the Dutch in imitation of them, ſometimes uſe the badiane to give their tea an aromatic taſte.

BADIGEON, a mixture of plaſter and free-ſtone, well ground together, and ſifted; uſed by ſtatuaries to fill up the little holes, and repair the defects in ſtones, whereof they make their ſtatues and other work.

The ſame term is alſo uſed by joiners, for ſaw-duſt mixed with ſtrong glue, wherewith they fill up the chaps and other defects in wood, after it is wrought.

BADILE (Antonio), hiſtory and portrait painter, was born at Verona in 1480, and by great ſtudy and application acquired a more extenſive knowledge of the true principles of painting than any of his predeceſſors. He was confeſſedly a moſt eminent artiſt; but he derived greater honour from having two ſuch diſciples as Paolo Veroneſe and Baptiſta Zelotti, than he did even from the excellence of his own compoſitions. He died in 1560. His colouring was admirably good; his carnations beautiful; and his portraits preſerved the perfect reſemblance of fleſh and real life; nor had he any cauſe to envy the acknowledged merit of Titian, Giorgione, or the beſt of his cotemporaries.

BADIS, a fortreſs of Livonia, ſubject to Ruſſia. E. Long. 23. 10. N. Lat. 59. 15.

BADIUS (Conrad), and (Stephen Robert), his brother; French refugees; celebrated as printers at Geneva, and Conrad as an author. The latter died in 1566.

Bæckea, Bætylia.

BÆCKEA, in botany: A genus of the octandria order, belonging to the monogynia claſs of plants. The calyx is a permanent perianthium, conſiſting of a ſingle funnel-ſhaped leaf, cut in five ſegments at the brim; the corolla conſiſts of five roundiſh ſpreading petals inſerted into the calyx; the pericarpium is a globoſe capſule, made up of four valves, and containing four cells, in which are a few roundiſh angular ſeeds.

BÆTERRÆ, an ancient town of the Tertoſages in Gallia Narbonenſis; now *Beſiers*, on the eaſt bank of the Obris, now *Orbis*, or *Orbe*, in Lower Languedoc.

BÆTICA, a province of ancient Spain, ſo called from the famed river Bætis, afterwards *Tarteſſus*, now *Guadalquiver*, or the great river. It was bounded on the weſt by Luſitania; on the ſouth, by the Mediterranean, and Sinus Gaditanus; on the north, by the Cantabric ſea, now the Bay of Biſcay. On the eaſt and north-eaſt, its limits cannot be ſo well aſcertained, as they are very reaſonably thought to have been in a continual ſtate of fluctuation, as each petty monarch had an opportunity of encroaching upon his neighbour. The province was divided in two by the river Bætis already mentioned. On the one ſide of which, towards the Anas, were ſituated the Turdetani, from whence the kingdom was called *Turdetania*, though more generally known by the name of *Bæturia*. On the other ſide were ſituated the Baſtuli, Baſtetani, and Conteſtani, along the Mediterranean coaſts. The Baſtuli were ſuppoſed to be of Phœnician extract, and dwelt along the coaſts of the Mediterranean, till driven from thence by the Moors, they fled into the mountainous parts of Galicia, which they then called from their own name *Baſtulia*. The Baſtetani were ſeated higher up, on the ſame coaſts. The territories of both theſe made part of what has ſince become the kingdom of *Granada*; in which there is a ridge of very high mountains called from the abovementioned people, the *Baſtetanian mountains*. Mention is alſo made of their capital *Baſtetana*; a place of ſuch ſtrength, that King Ferdinand was ſix months beſieging it before he could take it from the Moors.—The whole province of Bætica, according to the moſt probable account, contained what is now called *Andaluſia*, part of the kingdom of Grenada, and the outward boundaries of Eſtremadura.

BÆTIS. See BÆTICA.

BÆTULO, a town of ancient Spain, in the Terraconenſis; now *Badelona* in Catalonia.

BÆTYLIA, anointed ſtones, worſhipped by the Phœnicians, by the Greeks before the time of Cecrops, and by other babarous nations. They were commonly of a black colour, and conſecrated to ſome god, as Saturn, Jupiter, the Sun, &c.—Some are of opinion that the true original of theſe idols is to be derived from the pillar of ſtone which Jacob erected at Bethel, and which was afterwards worſhipped by the Jews.

Theſe *bætylia* were much the object of the veneration of the ancient heathens. Many of their idols were no other. In reality, no ſort of idol was more common in the eaſtern countries, than that of oblong ſtones erected, and hence termed by the Greeks, λιθοι, *pillars*. In ſome parts of Egypt they were planted on both ſides of the highways. In the temple of of Heliogabulus, in Syria, there was one pretended to have fallen from heaven. There was alſo a famous black ſtone in Phrygia, ſaid to have fallen from heaven. The Romans ſent for it and the prieſts belonging to it with much ceremony, Scipio Naſika being at the head of the embaſſy.

Bæza, Bagdad.

BÆZA, a city of Andaluſia in Spain, ſeated on a high hill three miles from the Gaudalquiver; it is the ſee of a biſhop, and has a kind of univerſity founded by John d'Avila. It was taken from the Moors about the end of the 15th century. E. Long. 3. 15. N. Lat. 37. 45.

BAFFETAS, or BASTAS, a cloth made of coarſe white cotton-thread, which comes from the Eaſt Indies. That of Surat is the beſt.

BAFFIN'S BAY, a gulph of North America, running north-eaſt from Cape Farewel in Weſt Greenland, from 60° to 80° of north latitude.

BAFFO, a conſiderable town in the iſland of Cyprus, with a fort built near ancient Paphos, of which ſome conſiderable ruins yet remain, particularly ſome broken columns, which probably belonged to the temple of Venus. E. Long. 32. 20. N. Lat. 34. 50.

BAG, in commerce, a term ſignifying a certain quantity of ſome particular commodity: a bag of almonds, for inſtance, is about 300 weight; of aniſeeds, from 300 to 400, &c.

Bags are uſed in moſt countries to put ſeveral ſorts of coin in, either of gold, ſilver, braſs, or copper. Bankers, and others, who deal much in current caſh, label their bags of money, by tying a ticket or note at the mouth of the bag, ſignifying the coin therein contained, the ſum total, its weight, and of whom it was received. Tare is allowed for the bag.

BAG, among farriers, is when, in order to retrieve a horſe's loſt appetite, they put in an ounce of aſa-fœtida, and as much powder of ſavin, into a bag, to be tied to the bit, keeping him bridled for two hours, ſeveral times a-day; as ſoon as the bag is taken off, he will fall to eating. The ſame bag will ſerve a long time.

BAGAMADER, or BAGAMEDRI, a province of the kingdom of Abyſſinia in Africa. It is ſaid to receive its name from the great number of ſheep bred in it; *meder* ſignifying land or earth, and *bag* a ſheep. Its length is eſtimated about 60 leagues, and its breadth 20: but formerly it was much more extenſive; ſeveral of its provinces having been diſmembered from it, and joined to that of Tigre. A great part of it, eſpecially towards the eaſt, is inhabited by wandering Gallas and Caffres.

BAGAUDÆ, or BACAUDÆ, an ancient faction of peaſants, or malecontents, who ravaged Gaul. The Gauls being oppreſſed with taxes, roſe about the year of Chriſt 290, under the command of Amand and Elian; and aſſumed the name *bagaudæ*, which, according to ſome authors, ſignified in the Gallic language *forced rebels*; according to other, *tribute*; according to others, *robers*; which laſt ſignification others allow the word had, but then it was only after the time of the *bagaudæ*, and doubtleſs took its riſe from them.

BAGDAD, a celebrated city of Aſia in Irak Arabi, ſeated on the eaſtern banks of the Tigris, in E. Long. 43. 40. N. Lat. 33. 15. By many authors this city is very improperly called *Babylon*. The latter ſtood on the Euphrates at a conſiderable diſtance.

This city, for many years the capital of the Saracen empire,

Bagdad. empire, was founded by the khalif Al Manſur, the ſecond of the houſe of Al Abbas, after an attempt by the Rawandians to aſſaſſinate him, as already mentioned. See ARABIA, n° 184.

1 Why the city was built. The reaſons aſſigned by the Arabian hiſtorians for buiding the city of Bagdad are, That the abovementioned attempt to aſſaſſinate the khalif had diſguſted him at his Arabian ſubjects in general, and that the ſpot where Bagdad ſtood was at a conſiderable diſtance from the city of Cufa particularly; the inhabitants of which were remarkable for their treachery and inconſtancy, Al Manſur himſelf having felt ſeveral inſtances of it. Beſides, the people of Irak, who had always continued faithful to him, repreſented, that by building his capital near the confluence of the Euphrates and Tigris, it would be in a great meaſure ſecured from the inſults and attacks of thoſe who ſhould have an inclination to diſpute the kalifat with him; and that by being ſituated as it were in the middle of the tract comprehending the diſtricts of Baſra, Cufa, Waſet, Mawſel, and Swada, at no great diſtance from thoſe cities, it would be plentifully ſupplied with proviſions by means of the aforeſaid rivers.

2 Ancient city deſcribed. Concerning the origin of the name *Bagdad*, there are various accounts, which being equally uncertain and trifling, merit no attention. The firſt city that went by this name was ſituated on the weſtern bank of the Tigris; from whence Al Manſur diſpatched his ſon Al Mohdi with a body of Moſlem troops, to the oppoſite bank. Here the young prince took poſt, and fortified the place on which he had encamped with a wall, in order to cover his troops, as well as the workmen employed by his father on the other ſide of the river, from the incurſions of the Perſians, who ſeemed to have taken umbrage at the erection of a new metropolis ſo near the frontiers of their dominions. Hence that part of the city ſoon afterwards built on the eaſtern banks of the Tigris, received the name of the *Camp*, or *Fortreſs of Al Mohdi*. The khalif had a ſuperb and magnificent palace both in the eaſtern and weſtern part of the town. The eaſtern palace was ſurrounded on the land-ſide by a ſemicircular wall that had ſix gates; the principal of which ſeems to have been called *the gate of prefects*, whoſe entrance was generally kiſſed by the princes and ambaſſadors that came to the khalif's court. The weſtern part of the city was entirely round, with the khalif's palace in the centre, and having the great moſque annexed to it. The eaſtern part conſiſted of an interior and exterior town, each of which was ſurrounded by a wall. For ſome time the building of the city went but ſlowly on, owing to a ſcarcity of materials for building; for which reaſon the khalif was ſometimes inclined to remove the materials of Al Madayen the ancient metropolis of the Perſian empire. But, upon trial, he found the ſtones to be of ſuch an immenſe ſize, that the removal of them to Bagdad would be attended with great difficulty and expence; beſides, he conſidered that it would be a reflection upon himſelf to have it ſaid that he could not finiſh his metropolis without deſtroying ſuch a pile of building as perhaps could not be paralleled in the whole world; for which reaſons he at length gave over his deſign, and erected the city of Bagdad, moſt probably out of the ruins of the ancient cities of Seleucia and Cteſiphon, putting an end to his undertaking in the 149th year of the Hegira, or four years after Bagdad. the city was begun.

From the building the city of Bagdad to the death of Al Manſur, nothing very remarkable happened, excepting ſome irruptions made into the territories of the Greeks, and by the Arabs into ſome of the khalif's other territories. In the 157th year of the Hegira alſo, a grievous famine was felt in Meſopotamia, which was quickly after followed by a plague that deſtroyed great numbers. This year likewiſe, the Chriſtians, who had been all along very ſeverely dealt with by Al Manſur, were treated with the utmoſt rigour by Muſa Ebn Moſaab the khalif's governor; every one who was unable to pay the enormous tribute exacted of them being thrown into priſon without diſtinction.

3 Death of Al Manſur. The next year being the 158th of the Hegira, the khalif ſet out from Bagdad, in order to perform the pilgrimage to Mecca: but being taken ill on the road, he expired at Bir Maimun, whence his body was carried to Mecca; where, after 100 graves had been dug, that his ſepulchre might be concealed, he was interred, having lived, according to ſome 63, according to others 68 years, and reigned 22. He is ſaid to have been extremely covetous, and to have left in his treaſury 600,000,000 dirhems, and 24,000,000 dinars. He is reported to have paid his cook by aſſigning him the heads and legs of the animals dreſſed in his kitchen, and to have obliged him to procure at his own expence all the fuel and veſſels he had occaſion for.

4 Succeeded by Al Mohdi. When Al Manſur expired at Bir Maimun, he had only his domeſtics and Rabi his freedman with him. The latter of theſe, for ſome time, kept his death concealed, and pretended to have a conference with him; in which, as he gave out, the khalif commanded him to exact an oath of allegiance to Al Mohdi his ſon, as his immediate ſucceſſor, and to Iſa Ebn Muſa his couſin-german, as the next apparent heir to the crown. He then diſpatched a courier to Bagdad with the news of Al Manſur's death; upon which Al Mohdi was unanimouſly proclaimed khalif. Iſa Ebn Muſa, however, no ſooner heard this news, than he began to entertain thoughts of ſetting up for himſelf at Cufa, where he then reſided; and in order to facilitate the execution of his ſcheme, fortified himſelf in that city. but Al Moluda being apprized of his defection, ſent a detachment of 1000 horſe to bring him to Bagdad; which being done, Al Mohdi not only prevailed upon him to own his allegiance to him, but alſo to give up his right to the ſucceſſion for 10,000 according to ſome, or, according to others, for 10,000,000, dinars.

5 Rebellion of Al Mokanna. From the acceſſion of Al Mohdi to the 164th year of the Hegira, the moſt remarkable event was the rebellion of Al Mokanna. This impious impoſtor, whoſe true name was *Hakem Ebn Heſham*, came originally from Khoraſan, and had been an under ſecretary to Abu Moſlem governor of that province. He afterwards turned ſoldier, and paſſed thence into Mawaralnah, where he gave himſelf out for a prophet. The name of Al Mokanna, as alſo that of Al Borkai, that is, the *veiled*, he took from his cuſtom of covering his face with a veil or girdle maſk, to conceal his deformity; he having loſt an eye in the wars, and being otherwiſe of a deſpicable appearance; though his followers pretended he did this for the ſame reaſon that

Bagdad.

Moſes did, viz. leſt the ſplendor of his countenance ſhould dazzle the eyes of his beholders. In ſome places he made a great many proſelytes, deluding the people with a number of juggling tricks which they ſwallowed as miracles, and particularly by cauſing the appearance of a moon to riſe out of a well for many nights together; whence he was alſo called in the Perſian tongue, *Sazendeh mak*, or the *moon-maker*. This wretch, not content with being reckoned a prophet, arrogated to himſelf divine honours; pretending that the Deity reſided in his perſon, having proceeded to him from Abu Moſlem, in whom he had taken up his reſidence before. At laſt this impoſtor raiſed an open rebellion again the khalif, and made himſelf maſter of ſeveral fortified places in Khoraſan, ſo that Al Mohdi was obliged to ſend one of his generals with an army againſt him. Upon the approach of the khalif's troops, Al Mokanna retired into one of his ſtrong fortreſſes which he had well provided for a ſiege; and ſent his emiſſaries abroad to perſuade the people that he raiſed the dead to life, and foretold future events.

6 Dreadful cataſtrophe of him and his family.

But being cloſely beſieged by the khalif's forces, and ſeeing no poſſibility of eſcaping, he gave poiſon in wine to his whole family and all that were with him in the caſtle; when they were dead, he burnt their bodies, together with all their furniture, proviſions, and cattle; and laſtly, he threw himſelf into the flames, or, as others ſay, into a tub of aqua-fortis, or ſome other preparation, which conſumed every part of him except the hair. When the beſiegers therefore entered the place, they found no living creature in it, except one of Al Mokanna's concubines, who, ſuſpecting his deſign, had hid herſelf, and now diſcovered the whole matter. This terrible contrivance, however, failed not to produce the deſired effect. He had promiſed his followers, that his ſoul ſhould tranſmigrate into the form of an old man, riding on a greyiſh coloured beaſt, and that after ſo many years he would return and give them the earth for their poſſeſſion; which ridiculous expectation kept the ſect in being for ſeveral years.

7 Harun Alraſhid's ſucceſs againſt the Greeks.

All this time war had been carried on with the Greeks, but without any remarkable ſucceſs on either ſide. In the 164th year of the Hegira, however, Al Mohdi ordered his ſon Harun Al Raſhid to penetrate into the Greek territories with an army of 95,000 men. Harun, then, having entered the dominions of the empreſs Irene, defeated one of her commanders that advanced againſt him; after which he laid waſte ſeveral of the imperial provinces with fire and ſword, and even threatened the city of Conſtantinople itſelf. By this the empreſs was ſo terrified, that ſhe purchaſed a peace with the khalif by paying him an annual tribute of 70,000 pieces of gold; which, for the preſent at leaſt, delivered her from the depredations of theſe barbarians. After the ſigning of the treaty, Harun returned home laden with ſpoil and glory.

8 Unaccountable darkneſs.

This year, according to ſome of the oriental hiſtorians, the ſun, one day, a little after his riſing, totally loſt his light in a moment, without being eclipſed, when neither any fog nor any cloud of duſt appeared to obſcure him. This frightful darkneſs continued till noon, to the great aſtoniſhment of the people ſettled in the countries where it happened*.

*See *Aſtronomy*, n° 57 and 486.

In the 169th year of the Hegira, Al Mohdi was poiſoned, though undeſignedly, by one of his concubines named *Haſanah*. She had deſigned to deſtroy one of her rivals, whom ſhe imagined to have too great an aſcendant over the khalif, by giving her a poiſoned pear. This the latter, not ſuſpecting any thing, gave to the khalif; who had no ſooner eaten it than he felt himſelf in exquiſite torture, and ſoon after expired.

Bagdad.

9 Al Mohdi poiſoned.

10 As likewiſe his ſucceſſor Al Hadi.

On the death of Al Mohdi, he was ſucceeded by his eldeſt ſon Al Hadi; who having formed a deſign to deprive his younger brother Harun Al Raſhid of his right of ſucceſſion, and even to aſſaſſinate him, was poiſoned by his vizier in the 170th year of the Hegira; and on his death the celebrated khalif Harun Alraſhid aſcended the throne.

11 Harun Al Raſhid khalif.

This was one of the beſt and wiſeſt princes that ever ſat on the throne of Bagdad. He was alſo extremely fortunate in all his undertakings, tho' he did not much extend his dominions by conqueſt. In his time the Moſlem empire may be ſaid to have been in its moſt flouriſhing ſtate, though, by the independency of the Moſlems in Spain, who had formerly ſet up a khalif of the houſe of Ommiyah, his territories were not quite ſo extenſive as thoſe of ſome of his predeceſſors.

12 Extent of his empire.

He poſſeſſed the provinces of Syria, Paleſtine, Arabia, Perſia, Armenia, Natolia, Media or *Aderbijan*, Babylonia, Aſſyria, Sindia, Sijiſtan, Khoraſan, Tabreſtan, Jorjan, Zableſtan, or *Sableſtan*, Mawaralnahr, or *Great Bukharia*, Egypt, Lybia, Mauritania, &c.; ſo that his empire was by far the moſt powerful of any in the world, and extended farther than the Roman empire ever had done.

13 He finds a ring he had thrown into the Tigris.

The firſt inſtance of Harun's good fortune, and which was taken for a preſage of a proſperous and happy reign, was his finding a valuable ring which he had thrown into the Tigris to avoid being deprived of it by his brother Al Hadi. He was able to give the divers no other direction than by throwing a ſtone from the bridge of Bagdad, about the ſame place of the river in which he had thrown the ring: notwithſtanding which, they found it without any great difficulty.

14 Divides the empire among his ſons, and ſettles the ſucceſſion.

In the 186th year of the Hegira, beginning January 10th, 802, the khalif divided the government of his extenſive dominions among his three ſons in the following manner: To Al Amin the eldeſt, he aſſigned the provinces of Syria, Irak, the three Arabias, Meſopotamia, Aſſyria, Media, Paleſtine, Egypt, and all that part of Africa extending from the confines of Egypt and Ethiopia to the ſtraits of Gibraltar, with the dignity of khalif; to Al Mamun the ſecond, he aſſigned Perſia, Kerman, the Indies, Khoraſan, Tabreſtan, Cableſtan and Zableſtan, together with the vaſt province of Mawaralnahr; and to his third ſon Al Kaſem, he gave Armenia, Natolia, Jorjan, Georgia, Circaſſia, and all the Moſlem territories bordering upon the Euxine ſea. As to the order of ſucceſſion, Al Amin was to aſcend the throne immediately after his father's deceaſe; after him Al Mamun; and then Al Kaſem, whom he had ſurnamed *Al Mutaman*.

15 His ſucceſsful wars with the Greeks.

The moſt conſiderable exploits performed by this khalif were againſt the Greeks, who by their perfidy provoked him to make war upon them, and whom he always overcame. In the 187th year of the Hegira, the khalif received a letter from the Greek emperor Neciphorus

Bagdad. Nicephorus ſoon after he had been advanced to the imperial dignity, commanding him to return all the money he had extorted from the empreſs Irene, though that had been ſecured to him by the laſt treaty concluded with that princeſs, or expect ſoon to ſee an imperial army in the heart of his territories. This inſolent letter ſo exaſperated Harun, that he immediately aſſembled his forces and advanced to Heraclea, laying the country through which he paſſed waſte with fire and ſword. For ſome time alſo he kept that city ſtraitly beſieged; which ſo terrified the Greek emperor, that he ſubmitted to pay an annual tribute. Upon this Harun granted him a peace, and returned with his army. But a hard froſt ſoon after happening in theſe parts, Nicephorus took for granted that Al Raſhid would not pay him another viſit, and therefore broke the treaty he had concluded. Of this the khalif receiving advice, he inſtantly put himſelf in motion; and, notwithſtanding the inclemency of the weather, forced the emperor to accept of the terms propoſed. According to a Perſian hiſtorian, before the hoſtilities at this time commenced, Nicephorus made the khalif a preſent of ſeveral fine ſwords, giving him thereby plainly to underſtand that he was more inclinable to come to blows than to make peace with him. All theſe ſwords Harun cut aſunder with his famous ſword *Samſamah*, as if they had been ſo many radiſhes, after which ſevere proof there did not appear the leaſt flaw in the blade; a clear proof of the goodneſs of the ſword, as the cutting the others with it was of the ſtrength of Harun's arm. This ſword had fallen into Al Raſhid's hands among the ſpoils of Ebn Dakikan, one of the laſt Hamyaritic princes of Yaman; but is ſaid to have belonged originally to a valiant Arab named *Amru Ebn Maadi Carb*, by whoſe name it generally went among the Moſlems. This man is ſaid to have performed very extraordinary feats with his ſword, which induced a certain prince to borrow it from him; but he not being able to perform any thing remarkable with it, complained to Amru that it had not the deſired effect: upon which that brave man took the liberty to tell him, that he had not ſent his arm along with his ſword.

In the 188th year of the Hegira, war was renewed with the Greeks, and Nicephorus with a great army attacked the khalif's forces with the utmoſt fury. He was, however, defeated with the loſs of 40,000 men, and received three wounds in the action; after which the Moſlems committed terrible ravages in his territories, and returned home laden with ſpoils. The next year Harun invaded Phrygia; defeated an imperial army ſent to oppoſe him; and having ravaged the country, returned without any conſiderable loſs. In the 190th year of the Hegira, commencing November 27th, 805, the khalif marched into the Imperial territories with an army of 135,000 men, beſides a great number of volunteers and others who were not inrolled among his troops. He firſt took the city of Heraclea, from whence he is ſaid to have carried 16,000 priſoners; after which he made himſelf maſter of ſeveral other places; and, in the concluſion of the expedition, he made a deſcent on the iſland of Cyprus, which he plundered in a terrible manner. This ſucceſs ſo intimidated Nicephorus, that he immediately ſent the tribute due to Harun, the withholding of which had been the cauſe of the war; and concludes a peace upon the khalif's own terms; one of which was, that the city of Heraclea ſhould never be rebuilt. This perhaps Harun would not have ſo readily granted, had not one Raſe Ebn Al Leith revolted againſt him at Samarcand, and aſſembled a conſiderable force to ſupport him in his deſection. Bagdad.

16 Rebellion in Khoraſan.

The next year, being the 191ſt of the Hegira, the khalif removed the governor of Khoraſan from his employment becauſe he had not been ſufficiently attentive to the motions of the rebel Raſe Ebn Al Leith. As this governor had alſo tyranized over his ſubjects in the moſt cruel manner, his ſucceſſor no ſooner arrived than he ſent him in chains to the khalif: but notwithſtanding all Harun's care, the rebels made this year a great progreſs in the conqueſt of Khoraſan.

Next year, the khalif found it neceſſary to march in perſon againſt the rebels, who were daily becoming more formidable. The general rendezvous of his troops was in the plains of Rakka, from whence he advanced at the head of them to Bagdad. Having at that place ſupplied the troops with every thing neceſſary, he continued his march to the frontiers of Jorjan, where he was ſeized with an illneſs which grew more violent after he had entered that province. Finding himſelf therefore unable to purſue his journey, he reſigned the command of the army to his ſon Al Mamun, retiring himſelf to Tus in Khoraſan. We are told by Khondemir, that, before the khalif departed from Rakka, he had a dream wherein he ſaw a hand over his head full of red earth, and at the ſame time heard a perſon pronouncing theſe words, "See the earth where Harun is to be buried."—Upon this he demanded where he was to be buried; and was inſtantly anſwered, "At Tus." This dream greatly diſcompoſing him, he communicated it to his chief phyſician, who endeavoured to divert him, telling the khalif that the dream had been occaſioned by the thoughts of his expedition againſt the rebels. He therefore adviſed him to purſue ſome favourite diverſion that might draw his attention another way. The khalif accordingly, by his phyſician's advice, prepared a magnificent regale for his courtiers, which laſted ſeveral days. After this, he put himſelf at the head of his forces, and advanced to the confines of Jorjan, where he was attacked by the diſtemper that proved fatal to him. As his diſorder increaſed, he found himſelf obliged to retire to Tus; where being arrived, he ſent for his phyſician, and ſaid to him, "Gabriel, do you remember my dream at Rakka? we are now arrived at Tus, the place, according to what was predicted in that dream, of my interment. Send one of my eunuchs to fetch me a handful of earth in the neighbourhood of this city." Upon this, *Maſrur*, one of his favourite eunuchs, was diſpatched to bring a little of the ſoil of the place to the khalif. He ſoon returned, and brought a handful of red earth, which he preſented to the khalif with his arm half bare. At the ſight of this, Harun inſtantly cried out, "In truth this is the earth, and this the very arm, that I ſaw in my dream." His ſpirits immediately failing, and his malady being greatly increaſed by the perturbation of mind enſuing upon this ſight, he died three days after, and was buried in the ſame place. According to Abul Faraj, Baſhir Ebn Al Leith the arch-rebel's brother, was brought in chains to the khalif, who was then at the point of death. At the ſight of whom Harun declared, that if

17 The khalif's death predicted by a dream.

18 He dies according to the prediction.

Bagdad. if he could ſpeak only two words he would ſay *kill him*; and immediately ordered him to be cut to pieces in his preſence. This being done, the khalif ſoon after expired, in the year of the Hegira 193, having reigned 23 years. The diſtemper that put an end to his days is ſaid to have been the bloody flux.

19 Succeeded by his ſon Al Amin. Upon the arrival of a courier from Tus, with the news of Al Raſhid's death, his ſon Al Amin was immediately proclaimed khalif; and was no ſooner ſeated on the throne, than he formed a deſign of excluding his brother Al Mamun from the ſucceſſion. Accordingly he deprived him of the furniture of the imperial palace of Khoraſan; and in open violation of his father's will, who had beſtowed on Al Mamun the perpetual government of Khoraſan; and of all the troops in that province, he ordered theſe forces to march directly to Bagdad. Upon the arrival of this order, Al Mamun expoſtulated with the general Al Fadl Ebn Rabi who commanded his troops, and endeavoured to prevent his marching to Bagdad; but without effect, for he punctually obeyed the orders ſent by the khalif. Al Mamun, however, took care not to be wanting in fidelity to his brother. He obliged the people of Khoraſan to take an oath of fidelity to Al Amin, and reduced ſome who had actually excited a conſiderable body of the people to revolt, while the general Al Fadl having ingratiated himſelf with the khalif by his ready compliance with his orders, was choſen prime vizir, and governed with an abſolute ſway; Al Amin abandoning himſelf entirely to drunkenneſs.

20 Infamous behaviour of the new khalif. Al Fadl was a very able miniſter; though fearing Al Mamun's reſentment if ever he ſhould aſcend the throne, he gave Al Amin ſuch advice as proved in the end the ruin of them both. He told him that his brother had gained the affection of the people of Khoraſan by the good order and police he had eſtabliſhed among them; that his unwearied application to the adminiſtration of juſtice had ſo attracted their eſteem, that the whole province was entirely at his devotion; that his own conduct was by no means reliſhed by his ſubjects, whoſe minds were almoſt totally alienated from him; and therefore that he had but one part to act, which was to deprive Al Mamun of the right of ſucceſſion that had been given him by his father, and transfer it to his own ſon Muſa, though then but an infant. Agreeable to this pernicious advice, the khalif ſent for his brother Al Kaſem from from Meſopotamia, and recalled Al Mamun from Khoraſan, pretending he had occaſion for him as an aſſiſtant in his councils.

21 Al Mamun takes up arms againſt his brother. By this treatment Al Mamun was ſo much provoked, that he reſolved to come to an open rupture with his brother, in order, if poſſible, to fruſtrate his wicked deſigns. Inſtead, therefore, of going to Bagdad as he had been commanded, he cut off all communication between his own province and that capital; pretending, that as his father Harun had aſſigned him the lieutenancy of Khoraſan, he was reſponſible for all the diſorders that might happen there during his abſence. He alſo coined money, and would not ſuffer Al Amin's name to be impreſſed upon any of the dirhems or dinars ſtruck in that province. Not content with this, he prevailed upon Rafe' Ebn Al Leith, who had been for ſome time in rebellion, to join him with a body of troops; whoſe example was ſoon after followed by Harthema Ebn Aafan; which put him in poſſeſſion of all the vaſt territory of Khoraſan. Here he governed with an abſolute ſway, officiated in the moſque as *Iman*, and from the pulpit conſtantly harangued the people. Bagdad.

The following year, being the 195th year of the Hegira, beginning October 4th, 810, the khalif Al Amin, finding that his brother ſet him at defiance, declared war againſt him, and ſent his general Ali Ebn Iſa with an army of 60,000 men to invade Khoraſan. Al Mamun, being informed that Ali was advancing againſt him with ſuch a powerful army, put on foot all the troops he could raiſe, and gave the command to Thaher Ebn Hoſein, one of the greateſt generals of his age. Thaher being a man of undaunted reſolution, choſe only 4000 men, whom he led againſt Al Amin's army. Ali, ſeeing ſo ſmall a number of troops advancing againſt him, was tranſported with joy, and promiſed himſelf an eaſy victory. Deſpiſing his enemies, therefore, he behaved in a ſecure and careleſs manner; the conſequence of which was, that his army was entirely defeated, and himſelf killed, his head being afterwards ſent as a preſent to Al Mamun, who amply rewarded Thaher and Harthema for their ſervices. 22 Al Amin's forces defeated.

After this victory, Al Mamun aſſumed the title of *khalif*, ordered Al Amin's name to be omitted in the public prayers, and made all neceſſary preparations for carrying the war into the very heart of his brother's dominions. For this purpoſe he divided his forces into two bodies, and commanded them to march into Irak by different routes. One of them obeyed the orders of Thaher, and the other of Harthema. The firſt directed his march towards Ahwas, and the other towards Holwan, both of them propoſing to meet in the neighbourhood of Bagdad, and after their junction to beſiege that city.

23 Al Mamun's rapid conqueſts. In the 196th year of the Hegira, Thaher Ebn Hoſein made a moſt rapid progreſs with the troops under his command. Having advanced towards Ahwas, he there defeated a body of the khalif's forces; and though the victory was by no means deciſive, it ſo intimidated the commander of Ahwas, that he thought fit to ſurrender that fortreſs to him. This opened him a way to Waſet upon the Tigris, and facilitated the conqueſt of that place. After this he marched with his army to Al Madayen; the inhabitants of which immediately opened their gates to him. The rapidity of theſe conqueſts, and the infamous conduct of Al Amin, excited the people of Egypt, Syria, Hejaz, and Yaman, unanimouſly to declare for Al Mamun; who was accordingly proclaimed khalif in all theſe provinces.

24 Siege of Bagdad. The next year, Al Mamun's forces under Thaher and Harthema laid ſiege to Bagdad. As the khalif was ſhut up in that place, and it had a numerous garriſon, the beſieged made a vigorous defence, and deſtroyed a great number of their enemies. The beſiegers, however, inceſſantly played upon the town with their catapults and other engines, though they were in their turn not a little annoyed by the garriſon with the ſame ſort of military machines. The latter likewiſe made continual ſallies, and fought like men in deſpair, though they were always at laſt beaten back into the town with conſiderable loſs. In ſhort, the ſiege continued during the whole of this year, in which the greateſt part of the eaſtern city, called the *Camp of Al Mohdi*, was demoliſhed or reduced to aſhes. The citizens, as well

Bagdad. well as the garriſon, were reduced to the laſt extremity by the length and violence of the ſiege.

In the beginning of the 198th year of the Hegira, Al Amin finding himſelf deſerted by his troops, as well as by the principal men of Bagdad, who had kept a private correſpondence with Thaher, was obliged to retire to the old town on the weſt bank of the Tigris. He did not, however, take this ſtep, before the inhabitants of the new town had formally depoſed him, and proclaimed his brother Al Mamun khalif. Thaher, receiving advice of this, cauſed the old town to be immediately inveſted, planted his engines againſt it, and at laſt ſtarved it to a ſurrender. Al Amin being thus reduced to the neceſſity of putting himſelf into the hands of one of the generals, choſe to implore the protection of Harthema, whom he judged to be of a more humane diſpoſition than Thaher. Having obtained this, he embarked in a ſmall veſſel in order to arrive at that part of the camp where Harthema was poſted; but Thaher being informed of his deſign, which, if put in execution, he thought would eclipſe the glory he had acquired, laid an ambuſh for him, which he had not the good fortune to eſcape. Upon his arrival in the neighbourhood of Harthema's tent, Thaher's ſoldiers ruſhed upon him, drowned all his attendants, and put himſelf in priſon. Here he was ſoon after maſſacred by Thaher's ſervants, who carried his head in triumph to their maſter, by whoſe order it was afterwards expoſed to public view in the ſtreets of Bagdad. Thaher afterwards ſent it to Al Mamun in Khoraſan, together with the ring or ſeal of the khalifat, the ſceptre, and the imperial robe. At the ſight of theſe, Al Mamun fell down on his knees, and returned thanks to God for his ſucceſs; making the courier who brought them a preſent of a million of dirhems, in value about L. 100,000 Sterling.

25 Al Amin murdered.

26 Succeeded by Al Mamun.

The ſame day that Al Amin was aſſaſſinated, his brother Al Mamun was proclaimed khalif at Bagdad. He had not been long ſeated on the throne when he was alarmed by rebellions breaking out in different parts of the empire. Theſe, however, were at laſt happily extinguiſhed; after which, Thaher Ebn Hoſein had the government of Khoraſan conferred upon him and his deſcendants with almoſt abſolute and unlimited power. This happened in the 205th year of the Hegira, from which time we may date the diſmemberment of that province from the empire of the khalifs.

27 Khoraſan diſmembered from the empire.

During the reign of this khalif nothing remarkable happened; only the African Moſlems invaded the iſland of Sicily, where they made themſelves maſters of ſeveral places. He died of a ſurfeit in the 218th year of the Hegira, having reigned 20, and lived 48 or 49 years.

28 Death of Al Mamun

On the death of Al Mamun, his brother Al Motaſem, by ſome of the oriental hiſtorians ſurnamed *Billah*, was ſaluted khalif. He ſucceeded by virtue of Al Mamun's expreſs nomination of him to the excluſion of his own ſon Al Abbas and his other brother Al Kaſem who had been appointed by Harun Al Raſhid. In the beginning of his reign he was obliged to employ the whole forces of his empire againſt one Babec, who had been for a conſiderable time in rebellion in Perſia and Perſian Irak. This Babec firſt appeared in the year of the Hegira 201, when he began to take upon him the title of a *prophet*. What his particular doctrine was, is now unknown; but his religion is ſaid to have differed from all others then known in Aſia. He gained a great number of proſelytes in Aderbijan and the Perſian Irak, where he ſoon grew powerful enough to wage war with the khalif Al Mamun, whoſe troops he often beat, ſo that he was now become extremely formidable. The general ſent by Al Motaſem to reduce him was Haider Ebn Kaus, ſurnamed *Afſhin*, a Turk by nation, who had been brought a ſlave to the khalif's court, and having been employed in diſciplining the Turkiſh militia there, had acquired the reputation of a great captain. By him Babec was defeated with prodigious ſlaughter, no fewer than 60,000 men being killed in the firſt engagement. The next year, being the 220th of the Hegira, he received a ſtill greater overthrow, loſing 100,000 men either killed or taken priſoners. By this defeat he was obliged to retire into the Gordyæan mountains; where he fortified himſelf in ſuch a manner, that Afſhin found it impoſſible to reduce him till the year of the Hegira 222. This commander having reduced with invincible patience all Babec's caſtles one after another, the impoſtor was obliged to ſhut himſelf up in a ſtrong fortreſs called *Caſbabad*, which was now his laſt reſource. Here he defended himſelf with great bravery for ſeveral months; but at laſt finding he ſhould be obliged to ſurrender, he made his eſcape into a neighbouring wood, from whence he ſoon after came to Afſhin, upon that general's promiſſing him pardon. But Afſhin no ſooner had him in his power, than he firſt cauſed his hands and feet, and afterwards his head, to be cut off. Babec had ſupported himſelf againſt the power of the khalifs for upwards of 20 years, during which time he had cruelly maſſacred 250,000 people; it being his cuſtom to ſpare neither man, woman, nor child, of the Mahometans or their allies. Amongſt the priſoners taken at Caſbabad there was one Nud, who had been one of Babec's executioners, and who owned that in obedience to his maſter's commands he had deſtroyed 20,000 Moſlems with his own hands; to which he added, that vaſt numbers had alſo been executed by his companions, but that of theſe he could give no preciſe account.

Bagdad.

30 Babec defeated.

31 Taken priſoner and put to death

32 He deſtroyed vaſt numbers of Moſlems.

In the 223d year of the Hegira, the Greek emperor Theophilus invaded the khalif's territories, where he behaved with the greateſt cruelty, and by deſtroying Sozopetra the place of Al Motaſem's nativity, notwithſtanding his earneſt intreaties to the contrary, occaſioned the terrible deſtruction of *Amorium* mentioned under that article. The reſt of this khalif's reign is remarkable for nothing but the execution of Afſhin, who was accuſed of holding correſpondence with the khalif's enemies. After his death a great number of idols were found in his houſe, which were immediately burned, as alſo ſeveral books ſaid to contain impious and deteſtable opinions.

33 Death of Al Motaſem.

In the 227th year of the Hegira died the khalif Al Motaſem, in the 48th or 49th year of his age. He reigned eight years eight months and eight days, was born in the eighth month of the year, fought eight battles had 8000 ſlaves, and had 8,000,000 dinars and 80,000 dirhems in his treaſury at his death, whence the oriental hiſtorians give him the name of *Al Mothamen*, or the *Octonary*. He is ſaid to have been ſo robuſt, that he once carried a burden of 1000 pounds weight ſeveral paces. As the people of Bagdad diſturbed him with frequent

29 War between the new khalif Al Motaſem and Babec.

Badgad.

frequent revolts and commotions, he took the reſolution to abandon that city, and build another for his own reſidence. The new city he built was firſt called *Samarra*, and afterwards *Sarra Manray*, and ſtood in the Arabian Irak. He was attached to the opinion of the Motazalites, who maintain the creation of the Koran; and both he and his predeceſſor cruelly perſecuted thoſe who believed it to be eternal.

34 He built the city of Sarra Manray.

35 His ſucceſſors Al Wathek and Al Motowakkel.

Al Motaſem was ſucceeded by Al Wathek Billah, who the following year, being the 228th of the Hegira, invaded and conquered Sicily. Nothing remarkable happened during the reſt of his reign; he died in the 232d year of the Hegira, and was ſucceeded by his brother Al Motawakkel.

36 Monſtrous cruelty of Al Motowakkel.

The new khalif began his reign with an act of the greateſt cruelty. The late khalif's vizir having treated Al Motawakkel ill in his brother's lifetime, and oppoſed his election to the khalifat, was on that account now ſent to priſon. Here the khalif ordered him to be kept awake for ſeveral days and nights together: after this, being ſuffered to fall aſleep, he ſlept a whole day and night; and after he awoke was thrown into an iron furnace lined with ſpikes or nails heated red hot, where he was miſerably burnt to death. During this reign nothing remarkable happened, except wars with the Greeks, which were carried on with various ſucceſs. In the year 859 too, being the 245th of the Hegira, violent earthquakes happened in many provinces of the Moſlem dominions; and the ſprings at Mecca failed to ſuch a degree, that the celebrated well Zemzem was almoſt dried up, and the water ſold for 100 dirhems a bottle.

37 He is aſſaſſinated.

In the 247th year of the Hegira, the khalif was aſſaſſinated at the inſtance of his ſon Al Montaſer; who ſucceeded him, and died in ſix months after. He was ſucceeded by Al Moſtain, who in the year of the Hegira 252 was forced to abdicate the throne by his brother Al Motazz, who afterwards cauſed him to be privately murdered. He did not long enjoy the dignity of which he had ſo iniquitouſly poſſeſſed himſelf; being depoſed by the Turkiſh militia (who now began to ſet up and depoſe khalifs as they pleaſed) in the 255th year of the Hegira. After his depoſition, he was ſent under an eſcort from Sarra Manray to Bagdad, where he died of thirſt or hunger, after a reign of four years and about ſeven months. The fate of this khalif was peculiarly hard: the Turkiſh troops had mutinied for their pay; and Al Motazz, not having money to ſatisfy their demands, applied to his mother named *Kabiha* for 50,000 dinars. This ſhe refuſed, telling him that ſhe had no money at all, although it afterwards appeared that ſhe was poſſeſſed of immenſe treaſures. After his depoſition, however, ſhe was obliged to diſcover them, and even depoſite them in the hands of the new khalif Al Mokhtadi. They conſiſted of 1,000,000 dinars, a buſhel of emeralds, and another of pearls, and three pounds and three quarters of rubies of the colour of fire.

38 Hard fate of Al Motazz a ſucceeding khalif.

Al Mokhtadi, the new khalif, was the ſon of one of Al Wathek's concubines named *Korb*, or *Karb*, who is by ſome ſuppoſed to have been a Chriſtian. The beginning of his reign is remarkable for the irruption of the Zenjians, a people of Nubia, Ethiopia, and the country of Caffres, into Arabia, where they penetrated into the neighbourhood of Baſra and Cuſa. The chief of this gang of robbers, who according to ſome of the Arab hiſtorians, differed but little from wild beaſts, was Ali Ebn Mohammed Ebn Abdalrahman, who falſely gave himſelf out to be of the family of Ali Ebn Abu Taleb. This made ſuch an impreſſion upon the Shiites in thoſe parts, that they flocked to him in great numbers; which enabled him to ſeize upon the cities of Baſra and Ramla, and even to paſs the Tigris at the head of a formidable army. He then took the title of *Prince of the Zenjians*, in order to ingratiate himſelf with thoſe barbarians, of whom his army was principally compoſed.

39 Irruption of the Zenjians in the reign of Al-Mokhtadi.

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In the 256th year of the Hegira, Al Mokhtadi was barbarouſly murdered by the Turks who had raiſed him to the throne, and was ſucceeded by Al Montamed the ſon of Al Motawakkel. This year the prince of the Zenjians, Ali, or as he is alſo called, *Al Habib*, made incurſions to the very gates of Bagdad, doing prodigious miſchief wherever he paſſed. The khalif therefore ſent againſt him one Jolan with a conſiderable army; he was overthrown, however, with very great ſlaughter by the Zenjian, who made himſelf maſter of 24 of the khalif's largeſt ſhips in the bay of Baſra, put a vaſt number of the inhabitants of Obolla to the ſword, and ſeized upon the town. Not content with this, he ſet fire to it, and ſoon reduced it to aſhes, the houſes moſtly conſiſting of the wood of a certain plane-tree called by the Arabians *Saj*. From thence he marched to Abadan, which likewiſe ſurrendered to him. Here he found an immenſe treaſure, which enabled him to poſſeſs him of the whole diſtrict of Ahwaz. In ſhort, his forces being now increaſed to 80,000 ſtrong, moſt of the adjacent territories, and even the khalif's court itſelf, were ſtruck with terror.

30 Al Habib's ſucceſs.

In the 257th year of the Hegira, Al Habib continued victorious, defeated ſeveral armies ſent againſt him by the khalif, reduced the city of Baſrah, and put 20,000 of the inhabitants to the ſword. The following year, the khalif, ſupported by his brother Al Mowaffek, had formed a deſign of circumſcribing the power of the Turkiſh ſoldiery, who had for ſome time given law to the khalifs themſelves. But this year the Zenjians made ſo rapid a progreſs in Perſia, Arabia, and Irak, that he was obliged to ſuſpend the execution of his deſign, and even to employ the Turkiſh troops to aſſiſt his brother Al Mowaffek in oppoſing theſe robbers. The firſt of the khalif's generals who encountered Al Habib this year, was defeated in ſeveral engagements, and had his army at laſt entirely deſtroyed. After this Al Mowaffek and another general named *Moſleh* advanced againſt him. In the firſt engagement Moſleh being killed by an arrow, the khalif's troops retired; but Al Mowaffek put them afterwards in ſuch a poſture of defence, that the enemy durſt not renew the attack. Several other ſharp encounters happened this year, in which neither party gained great advantage; but, at laſt, ſome contagious diſtempers breaking out in Al Mowaffek's army, he was obliged to conclude a truce, and retire to Waſet to refreſh his troops.

In the 259th year of the Hegira, commencing Nov. 7th, 872, the war between the khalif and Al Habib ſtill continued. Al Mowaffek, upon his arrival at Bagdad, ſent Mahammed, ſurnamed *Al Mowalled*, with a powerful army to act againſt the Zenjians: but he could not hinder them from ravaging the province of Ahwaz,

cut-

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cutting off about 50,000 of the khalif's ſubjects, and diſmantling the city of Ahwas; and notwithſtanding the utmoſt efforts of all the khalif's generals, no conſiderable advantages could be gained either this or the following year.

41 Rebellion in Fars, Ahwas, and Baſra.

In the 261ſt year of the Hegira, beginning October 16th, 874, Mohammed Ebn Waſel, who had killed the khalif's governor of Fars, and afterwards made himſelf maſter of that province, had ſeveral engagements with Al Habib, but with what ſucceſs is not known. The khalif, having been apprized of the ſtate of affairs on that ſide, annexed the government of Fars, Ahwas, and Baſra, to the prefecture he had given to Muſa Ebn Boga, whom he looked upon as one of the beſt generals he had. Muſa, ſoon after his nomination to that poſt, ſent Abdalrahman Ebn Moſleh as his deputy to Ahwas, giving him as a colleague and aſſiſtant one Tiſam, a Turk. Mohammed Ebn Waſel, however, refuſing to obey the orders of Abdalrahman and Tiſam; a fierce conflict enſued, in which the latter were defeated, and Abdalrahman taken priſoner. After this victory, Mohammed advanced againſt Muſa Ebn Boga himſelf; but that general, finding he could not take poſſeſſion of his new government without a vaſt effuſion of blood, recalled the deputies from their provinces, and made the beſt of his way to Sarra Manray. After this, Yakub Ebn Al Leit, having taken Khoraſan from the deſcendants of Thaher, attacked and defeated Mohammed Ebn Waſel, ſeizing on his palace, where he found a ſum of money amounting to 40,000,000 dirhems.

42 Rebels defeated, but cannot be reduced.

The next year Yakub Ebn Al Leit being grown formidable by the acquiſition of Ahwas and a conſiderable portion of Fars, or at leaſt the Perſian Irak, declared war againſt the khalif. Againſt him Al Motamed diſpatched Al Mowaffek; who having defeated him with prodigious ſlaughter, plundered his camp, and purſued him into Khoraſan; where meeting with no oppoſition, he entered Niſabur, and releaſed Mahomet the Thaherian, whom Yakub had detained in priſon three years. As for Yakub himſelf, he made his eſcape with great difficulty, tho' he and his family continued ſeveral years in poſſeſſion of many of the conqueſts he had made. This war with Yakub proved a ſeaſonable diverſion in favour of Al Habib, who this year defeated all the forces ſent againſt him, and ravaged the diſtrict of Waſet.

43 Al Habib ſtill victorious.

The following year, being the 263d of the Hegira, beginning September 24th, 876, the khalif's forces, under the command of Ahmed Ebn Lebuna, gained two conſiderable advantages over Al Habib; but being at laſt drawn into an ambuſcade, they were almoſt totally deſtroyed, their general himſelf making his eſcape with the utmoſt difficulty; nor were the khalif's forces able, during the courſe of the next year, to make the leaſt impreſſion upon theſe rebels.

44 Rebellion in Egypt which cannot be ſuppreſſed.

In the 265th year of the Hegira, beginning September 3d, 878, Ahmed Ebn Tolun rebelled againſt the khalif, and ſet up for himſelf in Egypt. Having aſſembled a conſiderable force, he marched to Antioch, and beſieged Sima the governor of Aleppo, and all the provinces known among the Arabs, by the name of *Al Awaſem* in that city. As the beſieged found that he was reſolved to carry the place by aſſault, they thought fit, after a ſhort defence, to ſubmit, and to put Sima into his hands. Ahmed no ſooner had that officer in his power, than he cauſed him to be beheaded; after which he advanced to Aleppo, the gates of which were immediately opened unto him. Soon after, he reduced Damaſcus, Hems, Hamath, Kinniſrin, and Al Rakka, ſituated upon the eaſtern bank of the Euphrates. This rebellion ſo exaſperated Al Motamed, that he cauſed Ahmed to be publicly curſed in all the moſques belonging to Bagdad and Irak; and Ahmed on his part ordered the ſame malediction to be thundered out againſt the khalif in all the moſques within his juriſdiction. This year alſo a detachment of Al Habib's troops penetrated into Irak, and made themſelves maſters of four of the khalif's ſhips laden with corn; then they advanced to Al Nomanic, laid the greateſt part of it in aſhes, and carried off with them ſeveral of the inhabitants priſoners. After this they poſſeſſed themſelves of Jarjaraya, where they found many priſoners more, and deſtroyed all the adjacent territory with fire and ſword. This year there were four independent powers in the Moſlem dominions, beſides the houſe of Ommiyah in Spain; viz. The African Moſlems, or Aglabites, who had for a long time acted independently; Ahmed in Syria and Egypt; Al Leit in Khoraſan; and Al Habib in Arabia and Irak.

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45 Four independent powers in the khalif's nominal dominions.

In the 266th year of the Hegira, beginning Auguſt 23d, 879, Al Habib reduced Ramhormoz, burnt the ſtately moſque there to the ground, put a vaſt number of the inhabitans to the ſword, and carried away great numbers, as well as a vaſt quantity of ſpoil.—This was his laſt ſucceſsful campaign; for the year following, Al Mowaffek, attended by his ſon Abul Abbas, having attacked him with a body of 10,000 horſe, and a few infantry, notwithſtanding the vaſt diſparity of numbers (Al Habib's army amounting to 100,000 men), defeated him in ſeveral battles, recovered moſt of the towns he had taken, together with an immenſe quantity of ſpoil, and releaſed 5000 women that had been thrown into priſon by theſe barbarians. After theſe victories, Al Mowaffek took poſt before the city of Al Mabiya', built by Al Habib, and the place of his reſidence, burnt all the ſhips in the harbour; thoroughly pillaged the town; and then entirely diſmantled it. After the reduction of this place, in which he found immenſe treaſures, Al Mowaffek purſued the flying Zenjians, put ſeveral of their chiefs to the ſword, and advanced to Al Mokhtara, a city built by Al Habib. As the place was ſtrongly fortified, and Al Habib was poſted in its neighbourhood, with an army, according to Abu Jaafer Al Tabari, of 300,000 men, Al Mowaffek perceived that the reduction of it would be a matter of ſome difficulty. He therefore built a fortreſs oppoſite to it, where he erected a moſque, and coined money. The new city, from its founder, was called by the Arabs *Al Mowaffekkia*, and ſoon rendered conſiderable by the ſettlement of ſeveral wealthy merchants there. The city of Al Mokhtara being reduced to great ſtraits was at laſt taken by ſtorm, and given up to be plundered by the khalif's troops; after which Al Mowaffek defeated the numerous forces of Al Habib in ſuch a manner, that they could no more be rallied during that campaign.

46 Al Habib's bad ſucceſs and death.

The following year, being the 268th of the Hegira, Al Mowaffek penetrated again into Al Mabiya', and demoliſhed the fortifications which had been raiſed ſince its former reduction, though the rebels diſputed

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every inch of ground. Next year he again attacked Al Habib with great bravery; and would have entirely defeated him, had he not been wounded in the breaſt with an arrow, which obliged him to ſound a retreat. However, as ſoon as he was cured of his wound, Al Mowaffek advanced a third time to Al Mabiya', made himſelf maſter of that metropolis, threw down the walls that had been raiſed, put many of the inhabitants to the ſword, and carried a vaſt number of them into captivity.

The 27th year of the Hegira, commencing July 11th, 883, proved fatal to the rebel Al Habib. Al Mowaffek made himſelf a fourth time maſter of Al Mabiya', burnt all Habib's palace, ſeized upon his family, and ſent them to Sarra Manray. As for the uſurper himſelf, he had the good fortune to eſcape at this time; but being cloſely purſued by Al Mowaffek into the province of Ahwas, where the ſhattered remains of his forces were entirely defeated, he at laſt fell into the hands of the victor, who ordered his head to be cut off, and carried through a great part of that region which he had ſo long diſturbed. By this complete victory Al Mowaffek obtained the title of *Al Naſir Lidmilbah*, that is, *the protector of Mahometaniſm.* This year alſo died Ahmed Ebn Tolun, who had ſeized upon Egypt and Syria, as we have already obſerved; and was ſucceeded by his ſon *Khamarawiyah.*

47 Succeſs of the ſultan of Egypt.

The next year, a bloody engagement happened between the khalif's forces commanded by Al Mowaffek's ſon, and thoſe of Khamarawiyah, who had made an irruption into the khalif's territories. The battle was fought between Al Ramla and Damaſcus. In the beginning, Khamarawiyah found himſelf ſo hard preſſed, that his men were obliged to give way; upon which, taking for granted that all was loſt, he fled with great precipitation, even to the borders of Egypt; but, in the mean time, his troops being ignorant of the flight of their general, returned to the charge, and gained a complete victory. After this, Khamarawiyah, by his juſt and mild adminiſtration, ſo gained the affections of his ſubjects, that the khalif found it impoſſible to gain the leaſt advantage over him. In the 276th year of the Hegira, he overthrew one of the khalif's generals named Abul Saj, at Al Bathnia near the city of Damaſcus; after which he advanced to Al Rakka on the Euphrates, and made himſelf maſter of that place. Having annexed ſeveral large provinces to his former dominions, and left ſome of his friends in whom he could confide to govern them, he then returned into Egypt, the principal part of his empire, which now extended from the Euphrates to the borders of Nubia and Ethiopia.

48 Al Mowaffek dies.

The following year, being the 278th of the Hegira, was remarkable for the death of Al Mowaffek. He died of the elephantiaſis or leproſy; and while in his laſt illneſs, could not help obſerving, that of 100,000 men whom he commanded, there was not one ſo miſerable as himſelf. This year is alſo remarkable for the firſt diſturbances raiſed in the Moſlem empire by the Karmatians. The origin of this ſect is not certainly known; but the moſt common opinion is, that a poor fellow, by ſome called *Karmata*, came from Khuzeſtan to the villages near Cufa, and there pretended great ſanctity and ſtrictneſs of life, and that God had enjoined him to pray 50 times a-day; pretended alſo to invite people to the obedience of a certain Imam of the family of Mahomet; and this way of life he continued till he had made a very great party, out of whom he choſe twelve as his apoſtles to govern the reſt, and to propagate his doctrines. He alſo aſſumed the title of *prince*, and obliged every one of his earlier followers to pay him a dinar a-year. But Al Haidam, the governor of that province, finding men neglected their work, and their huſbandry in particular, to ſay thoſe 50 prayers a-day, ſeized the fellow, and having put him in priſon, ſwore that he ſhould die. This being overheard by a girl belonging to the governor, ſhe, out of compaſſion, took the key of the dungeon at night from under her maſter's head, releaſed the man, and reſtored the key to its place while her maſter ſlept. The next morning the governor found his priſoner gone; and the accident being publicly known, raiſed great admiration; Karmata's adherents giving out that God had taken him into heaven. After this he appeared in another province, and declared to a great number of people he got about him, that it was not in the power of any perſon to do him hurt; notwithſtanding which, his courage failing him, he retired into Syria, and was never heard of any more. After his diſappearance, the ſect continued and increaſed; his diſciples pretending that their maſter had manifeſted himſelf to be a true prophet, and had left them a new law, wherein he had changed the ceremonies and form of prayer uſed by the Moſlems, &c. From this year, 278, theſe ſectaries gave almoſt continual diſturbance to the khalifs and their ſubjects, committing great diſorders in Chaldæa, Arabia, and Meſopotamia, and at length eſtabliſhed a conſiderable principality.

49 Origin of the Karmatians.

50 Sultan of Egypt's daughter married to the khalif Al Motaded.

In the 279th year of the Hegira died the khalif Al Motamed; and was ſucceeded by Al Motaded, ſon to Al Mowaffek. The firſt year of his reign, Al Motaded demanded in marriage the daughter of Khamarawiyah, ſultan, or khalif, in Egypt; which was agreed to by him with the utmoſt joy, and their nuptials were ſolemnized with great pomp in the 282d year of the Hegira. He carried on a war with the Karmatians; but very unſucceſsfully, his forces being defeated with great ſlaughter, and his general Al Abbas taken priſoner. This khalif alſo granted to Harun, ſon to Khamarawiyah, the perpetual prefecture of Awaſam and Kinniſrin, which he annexed to that of Egypt and Syria, upon condition that he paid him an annual tribute of 45,000 dinars. He died in the year of the Hegira 289, and was ſucceeded by his ſon Al Moctaſi.

51 Egypt, &c. recovered by the khalif Al Moctaſi.

This khalif proved a warlike and ſucceſsful prince. He gained ſeveral advantages over the Karmatians, but was not able to reduce them. The Turks, however, having invaded the province of Mawarnalnahr, were defeated with great ſlaughter; after which, Al Moctaſi carried on a ſucceſsful war againſt the Greeks, from whom he took Seleucia. After this he invaded Syria and Egypt, which provinces he recovered from the houſe of Ahmed Ebn Tolun.

52 Diſtreſſed ſtate of the khalifs after his death.

The reduction of Egypt happened in the 292d year of the Hegira, after which the war was renewed with ſucceſs againſt the Greeks and Karmatians. The khalif died in the 295th year of the Hegira, after a reign of about ſix years and a half. He was the laſt of the khalifs who made any figure by their warlike exploits. His ſucceſſors Al Moktader, Al Kaher, and Al Radi, were

Bagdad.

were ſo diſtreſſed by the Karmatians and numberleſs uſurpers who were every day ſtarting up, that by the 325th year of the Hegira, they had nothing left but the city of Bagdad. In the 324th year of the Hegira, commencing November 30th, 935, the khalif Al Radi, finding himſelf diſtreſſed on all ſides by uſurpers, and having a vizir of no capacity, inſtituted a new office ſuperior to that of vizir, which he intitled *Emir Al Omra*, or *Commandant of Commandants*. This great officer was truſted with the management of all military affairs, and had the entire management of the finances in a much more abſolute and unlimited manner than any of the khalif's vizirs ever had. Nay, he officiated for the khalif in the great moſque at Bagdad, and had his name mentioned in the public prayers throughout the kingdom. In ſhort, the khalif was ſo much under the power of this officer, that he could not apply a ſingle dinar to his own uſe without the leave of the Emir Al Omra. In the year 325, the Moſlem empire, once ſo great and powerful, was ſhared among the following uſurpers:

53 New office of Emir Al Omra inſtituted by Al Radi.

54 Diviſion of the Moſlem empire in the 325th year of the Hegira.

The cities of Waſet, Baſra, and Cufa, with the reſt of the Arabian Irak, were conſidered as the property of the Emir Al Omra, though they had been in the beginning of the year ſeized upon by a rebel called *Al Baridi*, who could not be driven out of them.

The country of Fars, Farſeſtan, or *Perſia*, properly ſo called, was poſſeſſed by Amado'ddawla Ali Ebn Buiya, who reſided in the city of Shiraz.

Part of the tract denominated *Al Jebal*, together with Perſian Irak, which is the mountainous part of Perſia, and the country of the ancient Parthians obeyed Rucno'ddawla, the brother of Amado'ddawla, who reſided at Iſpahan. The other part of that country was poſſeſſed by Waſhmakin the Deylamite.

Diyar Rabia, Diyar Beer, Diyar Modar, and the city of Al Mawſel, or Moſul, acknowledged for their ſovereign a race of princes called *Hamdanites*.

Egypt and Syria no longer obeyed the khalifs, but Mahomet Ebn Taj, who had formerly been appointed governor of theſe provinces.

Africa and Spain had long been independent.

Cicily and Crete were governed by princes of their own.

The provinces of Khoraſan and Marawalnahr were under the dominion of Al Naſr Ebn Ahmed, of the dynaſty of the Sammarians.

The provinces of Tabreſtan, Jorjan or Georgiana, and Mazanderan, had kings of the firſt dynaſty of the Deylamites.

The province of Kerman was occupied by Abu Ali Mahomet Ebn Eylia Al Sammani, who had made himſelf maſter of it a ſhort time before. And,

Laſtly, the provinces of Yamama and Bahrein, including the diſtrict of Hajr, were in the poſſeſſion of Abu Thaher the Karmatian.

Thus the khalifs were deprived of all their dominions, and reduced to the rank of ſovereign pontiffs; in which light, though they continued for ſome time to be regarded by the neighbouring princes, yet their power never arrived to any height. In this low ſtate the khalifs continued till the year of the Hegira 656, commencing January 8th, 1258. This year was rendered remarkable by the taking of Bagdad by Hulaku the Mogul or Tartar; who likewiſe aboliſhed the khalifat, putting the reigning khalif Al Moſtaſem Billah to a moſt cruel death. Theſe diabolical conquerors, after they had taken the city, maſſacred, according to cuſtom a vaſt number of the inhabitants; and after they had plundered it, ſet it on fire. The ſpoil they took from thence was prodigiouſly great, Bagdad being then looked upon as the firſt city in the world.

55 Bagdad taken by the Tartars.

Bagdad.

56 Hiſtory of the city ſince that time.

Bagdad remained in the hands of the Tartars or Moguls to the year of the Hegira 795, of Chriſt 1392, when it was taken by Tamerlane from Sultan Ahmed Ebn Weis; who being incapable of making head againſt Tamerlane's numerous forces, found himſelf obliged to ſend all his baggage over the Tigris, and abandon his capital to the conqueror. He was, however, hotly purſued by his enemy's detachments to the plain of Karbella, where ſeveral ſkirmiſhes happened, and a conſiderable number of men were loſt on both ſides. Notwithſtanding this diſaſter, he found means to eſcape the fury of his purſuers, took refuge in the territories of the Greek emperor, and afterwards repoſſeſſed himſelf of the city of Bagdad. There he remained till the year of the Hegira 803, when the city was taken a ſecond time by Tamerlane; who nevertheleſs reſtored it to him, and he continued ſovereign of the place till driven from thence by Miram Shah. Still, however, he found means to return; but in the 815th year of the Hegira was finally expelled by Kara Yuſef the Turkman. The deſcendants of Kara Yuſef continued maſters of Bagdad till the year of the Hegira 875, of Chriſt 1470, when they were driven out by Uſun Caſſun. The family of this prince continued till the year of the Hegira 914, of our Lord 1508, when Shah Iſhmael, ſurnamed *Sufi* or *Sofi*, the firſt prince of the royal family reigning in Iran or Perſia, till the dethroning of the late Shah Hoſein, made himſelf maſter of it. From that time to this Bagdad has continued to be a bone of contention between the Turks and Perſians. It was taken by Soliman ſurnamed the *magnificent*, and retaken by Shah Abbas the great, king of Perſia: but being at laſt beſieged by Amruth or Morad IV. with a formidable army, it was finally obliged to ſurrender to him in the year 1638; ſince which time the Perſians have never been able to make themſelves maſters of it for any length of time.

57 Its preſent ſtate.

The city is large and populous; and the advantage of the Tigris is ſo conſiderable, with regard to commerce, that although the climate is exceſſive hot, and in other reſpects far from being agreeable, yet the number of its inhabitants is computed at 300,000; but before the plague broke out there, they were ſuppoſed to be four times that number. It is governed by a baſhaw, whoſe authority extends as far as Courdiſtan. The revenues would be immenſe was the government mild; but inſtead thereof, oppreſſion rules here with the moſt deſpotic ſway. The baſhaw is continually extorting money from the poor inhabitants, and none ſuffer more than the unfortunate Jews and Chriſtians, many of whom are put to the moſt cruel tortures in order to force their property from them. This ſeries of tyranny and oppreſſion has almoſt entirely drove them out of the city, in conſequence of which the trade muſt ſuffer very conſiderably, they being generally the principal merchants in the place. In the months of June, July, and Auguſt, the weather is ſo extremely hot, as to oblige the inhabitants to live for

Bagdad. theſe months in ſubterraneous apartments, which are arched over, to admit the freer circulation of the air. The houſes are generally large, built of brick and cement, and are arched over; many of the windows are made of elegant Venetian glaſs; the ceilings are moſtly ornamented with a kind of chequered work, which has generally a noble appearance; moſt of the houſes have a court-yard before them, in the middle of which is a little plantation of orange trees, &c. that has a very pleaſing effect. The ſoil, which would produce not only every conveniency in life, but almoſt every luxury, is through the natural indolence of the Turks, and the many faults in the government of the country, in a great meaſure uncultivated and neglected. The revenues are computed at 125 lacks of piaſtres, or 1,562,500l. ſterling; but a quarter part of this is not collected, owing to the ſlothfulneſs of the Turks, who ſuffer the Arabs to plunder them of the remainder. This in ſome meaſure accounts for the cruelties and extortions that are continually practiſed here. As the baſhaw lives in all the ſplendor of a ſovereign prince, and maintains a very large army, he could not be able to defray his expences, was he not to have recourſe to oppreſſion and injuſtice; and he, by his extenſive power, acting almoſt independent of the Porte, only acknowledging it to bring in a balance from thence yearly in his favour.

The bazars or markets here are large and extenſive; being covered over with arches built of maſonry, and divided into different ſtreets, filled with ſhops of all kinds of merchandize, to the number of 12,000. Every thing a perſon can have occaſion for may be had there. The number of houſes in the city is computed at near 80,000; and each houſe and ſhop pay an annual tribute to the baſhaw, which is calculated to produce the ſum of 300,000l. ſterling. Beſides theſe immenſe revenues that are collected, the baſhaw pretends, that by repairs on the fortifications 30,000l. or 40,000l. are annually expended, when not ſo many hundreds are taken out of his coffers for that purpoſe. Likewiſe clearing the river and mending the bridge become a charge greater than their income, and probably not the value of an Engliſh ſhilling is expended. —To ſupport the expence of the ſeraglio, their clothes, capariſons of their horſes, and every outward pomp, the amount is conſiderable.

On the north ſide of the town ſtands the citadel, which commands the river; and conſiſts of curtains and baſtions, on which ſome very long cannon are mounted, with two mortars in each baſtion, placed no other beds than the ground, and in very bad condition. The carriages of the guns are likewiſe ſo unwieldy, and in ſuch a ſhattered condition, that from their appearances they would not ſupport one firing, but would be ſhaken in pieces. Their elevations were from 30 to 40 degrees, but they had no quoins to level them. There are beſides, a number of ſmall towers, and loop-holes for muſquetry, placed at certain diſtances, all well encompaſſed by a ditch of 27 feet deep, which can be filled at any time by the waters of the Tigris. The citadel is ſo cloſe to the houſes, that it might be eaſily taken if poſſeſſion was once gained of the town; but an attack made towards the land would not probably be ſucceſsful, as ſluices might with the greateſt facility be cut into the ditch, and ſo overflow the country for miles round; but it is ſaid an advantageous attack might be made from the water. Bagdad.

The city, which is fortified by lofty thick walls of brick covered with earth, and ſtrengthened by great towers much reſembling cavalier baſtions, the whole being ſurrounded by a deep ditch, is in the form of an irregular ſquare; but the walls in many places are broken down, occaſioned by the diſputes which happened on the death of Abdulla Baſha a few years ago, when two competitors aroſe in Bagdad for the baſhawic, who fought ſeveral times in the town and citadel, and laid great part of it in ruins. In the interim, the governor of Muſſool and Nineveh being appointed Baſhaw by the Porte, came hither with a conſiderable army, and took poſſeſſion of the ſovereignty, vanquiſhing his two opponents. Oppoſite to the city, on the other ſide of the river, are very extenſive ſuburbs, from whence ſhells might be thrown into the town, which would have a dreadful effect on a place ſo cloſely built. There is a communication beween the city and ſuburbs by a bridge of boats; the only kind of bridge which that river will admit of, as it is broad and deep, and in its ordinary courſe very rapid. At certain ſeaſons it ſwells to a prodigious height, and overflowing the country occaſions many moraſſes on that ſide oppoſite to the city. Among theſe are ſeveral towns and villages, whoſe inhabitants are ſaid to be the ancient Chaldeans: they are of a particular religion, which they pretend is that of Seth. The inhabitants of this city are compoſed chiefly of Perſians, Armenians, Turks, Arabs, and Jews, which laſt act in the capacity of ſchroffs, or bankers, to the merchants. The Jews, notwithſtanding the ſevere treatment they meet with from the government, are induced to live here from a reverence to the prophet Ezekiel, whoſe mauſoleum they pretend is a day's journey from the city. Beſides the Jews who reſide here, there are many that come every year out of devotion to viſit the prophet's tomb. There are alſo two European gentlemen, a Venetian and a Frenchman, with five Romiſh prieſts, who are Frenchmen and Italians. Two chapels are permitted for thoſe of the Romiſh and Greek perſuaſions; at the former the five prieſts officiate. In the city are ſeveral large beautiful moſques, but into which Chriſtians are never ſuffered to enter, if known to be ſuch, for fear it ſhould defile them. The Mahometan women are very richly dreſſed, wearing bracelets on their arms and jewels in their ears: the Arabian women have the partition between their noſtrils bored, wherein they wear rings.

There are alſo a number of antique buildings. At the diſtance of about ten miles ſtand the ruins of an ancient tower called the *Tower of Nimrod*. Whether this tower was at firſt of a ſquare or round form is now difficult to determine; though the former is moſt probable, becauſe all the remaining bricks are placed ſquare, and not in the leaſt circular. The bricks are all twelve inches ſquare and four and an half thick. The cement is of mud or ſlime, mixed with broken reed, as we mix hair with mortar; which ſlime might either have been had from one of the great rivers, or taken out of one of the ſwamps in the plain, with which the country hereabout very much abounds. The height of the ruin is 126 feet; the diameter of the

largeſt

Baggage. largeſt and middle part about 100 feet. It would appear to be ſolid to the centre; yet near the top there is a regular opening of an oval form. The circumference of that part of the tower which remains, and is above the rubbiſh, is about 300 feet; but probably, could the foundation be come at, it would be found of far greater extent. The preſent Turks, Jews, and Arabians, are fond of believing this to be the identical ruin of the ancient tower of Babel, for which they aſſign a variety of reaſons; but all ſo void of the appearance of truth, that to ſet about confuting them would be loſing time in trifles. It appears to have been a beacon or watch-tower, to give notice of the approach of an enemy: or perhaps was uſed as an obſervatory to inſpect the various motions of the heavenly bodies; which ſcience was ſo much cultivated among the ancient inhabitants of this country, that even the Grecians, though deſirous of being eſteemed the inventors of all arts and ſciences, could never deny the Babylonians the honour of having laid the foundations of aſtronomy.

BAGGAGE, in military affairs, denotes the clothes, tents, utenſils of divers ſorts, proviſions, and other neceſſaries belonging to the army.

Before a march, the waggons with the baggage are marſhalled according to the rank which the ſeveral regiments bear in the army; being ſometimes ordered to follow the reſpective columns of the army, ſometimes to follow the artillery, and ſometimes to form a column by themſelves. The general's baggage marches firſt; and each waggon has a flag, ſhowing the regiment to which it belongs.

Packing up the BAGGAGE, *vaſa colligere*, was a term among the Romans, for preparing to go to war, or to be ready for an expedition.

The Romans diſtinguiſhed two ſorts of baggage; a *greater* and *leſs*. The leſſer was carried by the ſoldier on his back, and called *ſarcina*; conſiſting of the things moſt neceſſary to life, and which he could not do without. Hence *colligere ſarcinas*, packing up the baggage, is uſed for decamping, *caſtra movere*. The greater and heavier was carried on horſes and vehicles, and called *onera*. Hence *onera vehiculorum, ſarcinæ hominum*. The baggage-horſes were denominated *ſagmentarii equi*.

The Roman ſoldiers in their marches were heavy loaden; inſomuch, that they were called by way of jeſt *muli mariani*, and *ærumnæ*. They had four ſorts of luggage, which they never went without, *viz.* corn, or *buccellatum*, utenſils, valli, and arms. Cicero obſerves, that they uſed to carry with them above half a month's proviſions; and we have inſtances in Livy, where they carried proviſions for a whole month. Their utenſils comprehended thoſe proper for gathering fuel, dreſſing their meat, and even for fortification or intrenchment; and what is more, a chain for binding captives. For arms, the foot carried a ſpear, ſhield, ſaw, baſket, rutrum, hatchet, lorum, falx, &c. Alſo ſtakes or pales, *valli*, for the ſudden fortifying a camp; ſometimes ſeven or even twelve of theſe pales were carried by each man, though generally, as Polybius tells us, only three or four. On the Trajan column we ſee ſoldiers repreſented with this fardle of corn, utenſils, pales, &c. gathered into a bundle and laid on their ſhoulders. Thus inured to labour, they grew ſtrong, and able to undergo any fatigue in battle; the greateſt heat of which never tired them, or put them out of breath. In after-times, when diſcipline grew ſlack, this luggage was thrown on carriages and porters ſhoulders. Baglana ‖ Bagnio.

The Macedonians were not leſs inured to hardſhip than the Romans; when Philip firſt formed an army, he forbid all uſe of carriages; yet, with all their load, they would march, in a ſummer's day, 20 miles in military rank.

BAGLANA, or BUGLANA, a province of the kingdom of Dekkan in the Mogul's empire. It is bounded on the north and eaſt by Guzerat and Ballagat; and on the ſouth and weſt by that part of Viziapur called *Konhan*, belonging to the Marattas. It ends in a point at the ſea-coaſt between Daman and Balſora, and is the leaſt province in the kingdom. The Portugueſe territories begin in this province at the port Daman, 21 leagues ſouth of Surat; and run along the coaſt by Baſſaim, Bombay, and Chawl, to Dabul, almoſt 50 leagues to the north of Goa.

BAGLIVI (George), a moſt illuſtrious phyſician of Italy, was a native of Apulia, and born about the year 1668. He ſtudied at Padua, where he became doctor; and then went to Rome, where he was choſen profeſſor of anatomy. He was a man of moſt uncommon force of underſtanding, of which he gave ample proofs in many curious and accurate productions, philoſophical as well as medicinal. He died at Rome 1706, in the flower of his age, and when he was no more than 38. A collection of his works were printed firſt in 1710, quarto; and have ſince been reprinted, in the ſame ſize, at various places. His *Praxis Medica*, and *De Fibra Matricis*, are the principal pieces. He wrote a Diſſertation upon the Anatomy, Bite, and Effects, of the Tarantula, which is the production of his country; and gave a particular account of the earthquake at Rome and the adjacent cities in 1703. His works are all in Latin.

BAGNAGAR, a town of Aſia, in the dominions of the Great Mogul, and capital of the kingdom of Golconda in the peninſula on this ſide the Ganges. The inhabitants within the town are the better ſort; the merchants and meaner people inhabiting the ſuburbs, which is three miles long. It is chiefly remarkable for a magnificent reſervoir of water, ſurrounded with a colonnade ſupported by arches. It is ſeated on the river Newa, in E. Long. 96. 0. N. Lat. 15. 30.

BAGNARA, a ſea-port town of Italy in the kingdom of Naples, in the farther Calabria, with the title of a duchy. E. Long. 16. 8. N. Lat. 38. 15.

BAGNAREA, a town of Italy in St Peter's patrimony, and in the territory of Orvieta, with a biſhop's ſee. E. Long. 12. 10. N. Lat. 42. 36.

BAGNERES, a town of France in Gaſcony, and in the county of Bigorre, ſo called from its mineral waters. It is ſeated on the river Adour, in E. Long. 0. 12. N. Lat, 43. 3.

BAGNIALACK, a large town of Turkey in Europe, in the province of Boſnia. E. Long. 18. 10. N. Lat. 44. 0.

BAGNIO, an Italian word, ſignifying *a bath*. We uſe it for a houſe with conveniences for bathing, cupping, ſweating, and otherwiſe cleanſing the body; and ſometimes for worſe purpoſes. In Turkey it is become

Bagnolas
|
Bag-pipe.

come a general name for the priſons where the ſlaves are incloſed, it being uſual in theſe priſons to have baths.

BAGNOLAS, a town of Lower Languedoc in France. It has a very handſome ſquare, and two fountains which riſe in the middle of the town; the waters of which, being received in a baſon, are conveyed by a canal out of town, and from thence to the lands about it. E. Long. 4. 43. N. Lat. 44. 10.

BAGNOLIANS, or BAGNOLANSES, in church-hiſtory, a ſect of heretics, who in reality were Manichees, though they ſomewhat diſguiſed their errors. They rejected the Old Teſtament and part of the New; held the world to be eternal; and affirmed that God did not create the ſoul when he infuſed it into the body.

BAGOI, among the ancient Perſians, were the ſame with thoſe called by the Latins *ſpadones*, *viz.* a ſpecies of eunuchs, in whom the canal of the penis was ſo contorted by a tight vinculum, that they could not emit the ſemen.

BAG-PIPE, a muſical inſtrument, of the wind kind, chiefly uſed in Scotland and Ireland. The peculiarity of the bag-pipe, and from which it takes its name, is, that the air which blows it is collected into a leathern bag, from whence it is preſſed out by the arm into the pipes. Theſe pipes conſiſt of a baſs, and tenor or rather treble; and are different according to the ſpecies of the pipe. The baſs part is called the *drone*, and the tenor or treble part the *chanter*. In all the ſpecies, the baſs never varies from its uniform note, and therefore very deſervedly gets the name of *drone*; and the compaſs of the chanter is likewiſe very limited. There is a conſiderable difference between the Highland and Lowland bag-pipe of Scotland; the former being blown with the mouth, and the latter with a ſmall bellows: though this difference is not eſſential, every ſpecies of bag-pipe being capable, by a proper conſtruction of the reeds, of producing muſic either with the mouth or bellows. The following are the ſpecies of bag-pipes moſt commonly known in Britain.

1. The *Iriſh Pipe*. This is the ſofteſt, and in ſome reſpects the moſt melodious of any, ſo that muſic-books have been publiſhed with directions how to play on it. The chanter, like that of all the reſt, has eight holes like the Engliſh flute, and is played on by opening and ſhutting the holes as occaſion requires; the baſs conſiſts of two ſhort drones, and a long one. The loweſt note of the chanter is D on the German flute, being the open note on the counter-ſtring of a violin; the ſmall drone (one of them commonly being ſtopped up) is tuned in uniſon with the note above this, and the large one to an octave below; ſo that a great length is required in order to produce ſuch a low note, on which account the drone hath ſometimes two or three turns. The inſtrument is tuned by lengthening or ſhortening the drone till it ſounds the note deſired.

2. The *Highland Bag-Pipe*. This conſiſts of a chanter and two ſhort drones, which ſound in uniſon the loweſt note of the chanter except one. This is exceedingly loud, and almoſt deafening if played in a room; and is therefore moſtly uſed in the fields, for marches, &c. It requires a prodigious blaſt to ſound it; ſo that thoſe unaccuſtomed to it cannot imagine how Highland pipers can continue to play for hours together, as they are often known to do. For the ſame reaſon, thoſe who uſe the inſtrument are obliged either to ſtand on their feet or walk when they play. This inſtrument hath but nine notes; its ſcale, however, hath not yet been reduced to a regular ſtandard by comparing it with that of other inſtruments, ſo that we can ſay nothing about its compaſs. Thoſe who are beſt acquainted with it, however, affirm that it plays only the natural notes, without being capable of variation by flats or ſharps. Bag-pipe.

3. The *Scots Lowland Pipe*. This is likewiſe a very loud inſtrument, though leſs ſo than the former. It is blown with bellows, and hath a baſs like the Iriſh pipe. This ſpecies is different from all the reſt, as it cannot play the natural notes, but hath F and C ſharp. The loweſt note of a good bag-pipe of this kind is uniſon with C ſharp on the tenor of a violin tuned concert-pitch; and as it hath but nine notes, the higheſt is D in alt. From this peculiar conſtruction, the Highland and Lowland bag-pipes play two ſpecies of muſic eſſentially different from one another, as each of them alſo is from every other ſpecies of muſic in the world. Hence theſe two ſpecies of bag-pipes deſerve notice as curioſities; for the muſic which they play is accompanied with ſuch peculiar ornaments, or what are intended as ſuch, as neither violin, nor even organ, can imitate, but in a very imperfect manner.

This kind of bag-pipe was formerly very much uſed in Scotland at weddings and other feſtivals: being indeed extremely well calculated for playing that peculiar ſpecies of Scots muſic called *reels*. It has been often a matter of ſurpriſe how this was poſſible, as the inſtrument has only a compaſs of nine or ten notes at the utmoſt, and which cannot be varied as in other inſtruments. In this reſpect, however, it has a very great compaſs, and will play an inconceivable variety of tunes. As its notes are naturally ſo high, there is ſcarce any one tune but what is naturally tranſpoſed by it, ſo that what would be a flat note on the key proper for the violin, may be a ſharp one on the bag-pipe; and though the latter cannot play any flat note, it may nevertheleſs in this manner play tunes which on other inſtruments would be flat, to as great perfection as theſe inſtruments themſelves.

4. *The Small Pipe*. This is remakable for its ſmallneſs, the chanter not exceeding eight inches in length; for which reaſon, the holes are ſo near each other, that it is with difficulty they can be cloſed. This hath only eight notes, the lower end of the chanter being commonly ſtopped. The reaſon of this is, to prevent the ſlurring of all the notes, which is unavoidable in the other ſpecies; ſo that in the hands of a bad player they become the moſt ſhocking and unintelligible inſtruments imaginable: but this, by having the lower hole cloſed, and alſo by the peculiar way in which the notes are expreſſed, plays all its tunes in the way called by the Italians *ſtaccato*, and cannot ſlur at all. It hath no ſpecies of muſic peculiar to itſelf; and can play nothing which cannot be much better done upon other inſtruments; though it is ſurpriſing what vollubility ſome performers on this inſtrument will diſplay, and how much they will overcome the natural diſadvantages of it. Some of this ſpecies, inſtead of having drones like the others, have their baſs parts conſiſting of a winding cavity in a kind

of

Bag-pipe.

of ſhort caſe, and are tuned by opening theſe to a certain degree by means of ſliding covers; from which contrivance they are called *ſhuttle-pipes*.—Beſides theſe, there are a variety of others, called *Italian*, *German*, *Organ*, &c. bag-pipes, which have nothing different in their conſtruction from thoſe above deſcribed, nor any good quality to recommend them.

As to the origin of bag-pipe muſic, ſome are of opinion that it is to be derived from the Danes; but Mr Pennant thinks differently, and gives the following reaſons for deriving it ftom Italy.

Voyage to the Hebrides, p. 302.

"Neither of theſe inſtruments (the Highland and Lowland bag-pipes above deſcribed) were the invention of the Danes, or, as is commonly ſuppoſed, of any of the northern nations; for their ancient writers prove them to have been animated by the *clangor tubarum*. Notwithſtanding they have had their ſœck-pipe long amongſt them, as their old ſongs prove, yet we cannot allow them the honour of inventing this melodious inſtrument; but muſt aſſert, that they borrowed it from the invaded Caledonians. We muſt ſtill go farther, and deprive even that ancient race of the credit; and derive its origin from the mild climate of Italy, perhaps from Greece.

"There is now in Rome a moſt beautiful bas relievo, a Grecian ſculpture of the higheſt antiquity, of a bag-piper playing on his inſtrument, exactly like a modern Highlander. The Greeks had their Ασκαυλης, or inſtrument, compoſed of a pipe and blown-up ſkin: the Romans in all probability borrowed it from them, and introduced it among their ſwains, who ſtill uſe it under the names of *piva* and *cornu-muſa*.

"That maſter of muſic, Nero, uſed one; and had not the empire been ſo ſuddenly deprived of that great artiſt, he would (as he graciouſly declared his intention, have treated the people with a concert, and, among other curious inſtruments, would have introduced the *utricularius* or bag-pipe. Nero periſhed; but the figure of the inſtrument is preſerved on one of his coins, but highly improved by that great maſter: it has the bag and two of the vulgar pipes; but was blown with a bellows like an organ, and had on one ſide a row of nine unequal pipes reſembling the ſyrinx of the god Pan. The bag-pipe, in the unimproved ſtate, is alſo repreſented in an ancient ſculpture; and appears to have had two long pipes or drones, and a ſingle ſhort pipe for the fingers. Tradition ſays, that the kind played on by the mouth was introduced by the Danes: as theirs was wind-muſic, we will admit that they might have made improvement; but more we cannot allow: they were ſkilled in the uſe of the trumpet; the Highlanders in the piohb, or bag-pipe,

Non tuba in uſu illis, conjecta at tibia in utrum
*Dat belli ſignum, et martem vocat horrida in arma**."

* *Melvini Topogr. Scotiæ.*

The bag-pipe appears to have been an inſtrument of great antiquity in Ireland, though it is uncertain whence they derived it. Mr Pennant, by means of an antique found at Richborough in Kent, has determined that the bag-pipe was introduced at a very early period into Britain; whence it is probable that both Iriſh and Danes might borrow the inſtrument from the Caledonians, with whom they had ſuch frequent intercourſe. Ariſtides Quintilianus informs us, that it prevailed in the Highlands in very early ages; and indeed the genius of the people ſeems to render the opinion highly probable. The attachment of that people to their muſic called pibrachs is almoſt incredible, and on ſome occaſions is ſaid to have produced effects little leſs marvellous than thoſe aſcribed to the ancient muſic. At the battle of Quebec in 1760, while the Britiſh troops were retreating in great diſorder, the general complained to a field-officer in Fraſer's regiment of the bad behaviour of his corps. "Sir (ſaid he with ſome warmth), you did very wrong in forbidding the pipers to play this morning; nothing encourages the Highlanders ſo much in the day of action. Nay, even now they would be of uſe."—"Let them blow like the devil, then (replies the general), if it will bring back the men." The pipers were then ordered to play a favourite martial air; and the Highlanders, the moment they heard the muſic, returned and formed with alacrity in the rear. In the late war in India, Sir Eyre Coote, aware of the attachment of the Highlanders to their favourite inſtrument, gave them L. 50 to buy a pair of bag-pipes after the battle of Porto Nuovo.

Bag-pipe || Bahama.

Formerly there was a kind of college in the iſland of Skie where the Highland bag-pipe was taught; the teachers making uſe of pins ſtuck into the ground inſtead of muſical notes. This college, however, has been for ſome time entirely diſſolved, and the uſe of the Highland pipe became much leſs general than before. At laſt a ſociety of gentlemen, thinking it perhaps impolitic to allow the ancient martial muſic of the country to decline, reſolved to revive it by giving an annual prize to the beſt peſormers on the inſtrument. Theſe competitions were firſt held at Falkirk, but for a good number of years at Edinburgh; where the only ſurviving member of the ancient college of Skie is now *profeſſor* of bag-pipe muſic.

The Lowland pipe, as has been already obſerved, is an inſtrument eſſentially different from the Highland pipe; it was reformed and the muſic improved by George Mackie, who is ſaid to have attended the college of Skie ſeven years. He had before been the beſt performer on that inſtrument in that part of the country where he lived; but, while attending the college at Skie, he adapted the graces of the Highland muſic to the Lowland pipe. Upon his return, he was heard with aſtoniſhment and admiration; but unluckily, not being able to commit his improvements to writing, and indeed the nature of the inſtrument ſcarce admitting of it, the knowledge of this kind of muſic hath continued to decay ever ſince, and will probably ſoon wear out altogether. What contributes much to this is, that the bag-pipers, not content with the natural nine notes which their inſtrument can play eaſily, force it to play tunes requiring higher notes, which diſorders the whole inſtrument in ſuch a manner as to produce the moſt horrid diſcords; and this practice brings, though undeſervedly, the inſtrument itſelf into contempt.

BAGUETTE, in architecture, a ſmall round moulding, leſs than an aſtragal, and ſo called from the reſemblance it bears to a ring.

BAHAMA, or LUCAYA, ISLANDS, are the eaſtermoſt of the Antilles, lying in the Atlantic ocean. They are ſituated to the ſouth of Carolina, between 22 and 27 degrees N. Lat. and 73 and 81 degrees W. Long. They extend along the coaſt of Florida quite down to the

Bahama Baharen.

the iſle of Cuba, and are ſaid to be 500 in number, ſome of them only mere rocks; but twelve of them are large, fertile, and in nothing different from the ſoil of Carolina: all are, however, uninhabited except Providence, which is 200 miles eaſt of the Floridas; though ſome others are larger and more fertile, on which the Engliſh have plantations. Between them and the continent of Florida is the gulf of Bahama, or Florida, through which the Spaniſh galeons ſail in their paſſage to Europe.

Theſe iſlands were the firſt fruits of Columbus's diſcoveries; but they were not known to the Engliſh till 1667, when Captain Seyle, being driven among them in his paſſage to Carolina, gave his name to one of them; and being a ſecond time driven upon it, gave it the name of *Providence*. The Engliſh, obſerving the advantageous ſituation of theſe iſlands for being a check on the French and Spaniards, attempted to ſettle them in the reign of Charles II. Some unlucky accidents prevented this ſettlement from being of any advantage; and the iſle of Providence became an harbour for the buccaneers or pirates, who for a long time infeſted the American navigation. This obliged the government in 1718 to ſend out Captain Woodes Rogers with a fleet to diſlodge the pirates, and for making a ſettlement. This the captain effected; a fort was erected, and an independent company was ſtationed in the iſland. Ever ſince this laſt ſettlement theſe iſlands have been improving, though they advance but ſlowly. In time of war, people gain conſiderably by the prizes condemned there; and at all times by the wrecks which are frequent in this labyrinth of rocks and ſhelves. The Spaniards and Americans captured theſe iſlands during the laſt war; but they were retaken by a detachment from St Auguſtine April 7, 1783.

BAHAR, or BARRE, in commerce, weights uſed in ſeveral places in the Eaſt Indies.

There are two of theſe weights; one the great bahar, with which they weigh pepper, cloves, nutmegs, ginger, &c. and contains 550 pounds of Portugal, or about 524 lb. 9 oz. averdupois weight. With the little bahar, they weigh quickſilver, vermilion, ivory, ſilk, &c. It contains about 437 lb. 9 oz. avoirdupois weight.

BAHAREN, an iſland in the Perſian gulf, ſituated in E. Long. 50. 0. N. Lat. 26. 0. This iſland is chiefly remarkable for its pearl-fiſhery, and has often changed its maſters. It fell with Ormus under the dominion of the Portugueſe, was again reſtored to Perſia by Thamas Khouli Kan; and after his death the confuſion into which his empire was thrown, gave an opportunity to an enterprizing and ambitious Arab of taking poſſeſſion of the iſland, where he ſtill maintains his authority. Baharen was famous for its pearl-fiſhery even at the time when pearls were found at Ormus, Karek, Kaſhy, and other places in the Perſian gulf; but it is now become of much greater conſequence; all the other banks having been exhauſted, while this has ſuffered no ſenſible diminution. The time of fiſhing begins in April, and ends in October. It is confined to a tract four or five leagues in breadth. The pearls taken at Baharen, though not ſo white as thoſe of Ceylon or Japan, are much larger than thoſe of the former place, and more regularly ſhaped than thoſe of the latter. They have a yellowiſh colour; but have alſo this good quality, that they preſerve their golden hue, whereas the whiter kind loſe much of their luſtre by keeping, eſpecially in hot countries. The annual revenue from the Baharen pearl-fiſhery is computed at about L.157,500. The greateſt part of the pearls that are uneven, are carried to Conſtantinople and other parts of Turkey, where the larger go to compoſe ornaments for head-dreſſes, and the ſmaller are uſed in embroideries. The perfect pearls muſt be reſerved for Surat, whence they are diſtributed through all Indoſtan.

Bahi Baja.

BAHI, a province of Lucon or Manila, one of the Philippine iſlands in the Eaſt Indies, belonging to the Spaniards. It is remarkable for producing excellent betel, which the inhabitants, Spaniards as well as natives, perpetually chew from morning till night. It is alſo the place where moſt of the ſhips are built. But the natives ſuffer much from this work; ſeveral hundreds of them being conſtantly employed in it, on the mountains, or at the port of Cavite. The king allows theſe labourers a piece-of-eight per month, with a ſufficient quantity of rice. The whole province contains about 6000 tributary natives.

BAHIA, DE TODOS LOS SANCTOS, a province of Braſil in South America, belonging to the Portugueſe, and the richeſt in the whole country; but unhappily the air and climate do not correſpond with other natural advantages: yet ſo fertile is the province in ſugar and other commercial articles, that the Portugueſe flock hither not only as it is the ſeat of affluence, but alſo of pleaſure and grandeur. The capital, called *St Salvador*, or *Cividad de Bachia*, is populous, magnificent, and beyond compariſon the moſt gay and opulent city in Braſil. It ſtands on a bay in S. Lat. 12. 11. is ſtrong by nature, well fortified, and always defended by a numerous garriſon. It contains 12,000 or 14,000 Portugueſe, and about three times as many negroes, beſides people of different nations who chooſe to reſide in that city.

BAHIR, a Hebrew term ſignifying *famous or illuſtrious*; but particularly uſed for a book of the Jews, treating of the profound myſteries of the caballa, being the moſt ancient of the Rabinical works.

BAHUS, a ſtrong town of Sweden, and capital of a government of the ſame name, ſeated on a rock in a ſmall iſland, in E. Long. 11. 10. N. Lat. 57. 52.

BAJA, BAYJAH, or BEGIA, a town of the kingdom of Tunis in Africa, ſuppoſed to be the ancient *Vacca* of Salluſt, and *Oppidum Vaggenſe* of Pliny. It was formerly, and ſtill continues to be, a place of great trade, and the chief market of the kingdom for corn; of which the adjacent territories produce ſuch abundance, that they can ſupply more than the whole kingdom with it; and the Tuneſians ſay, that if there was in the kingdom ſuch another town as this for plenty of corn, it would become as cheap as ſand. Here is alſo a great annual fair, to which the moſt diſtant Arabian tribes reſort with their families and flocks. Notwithſtanding all this, however, the inhabitants are very poor, and great part of the land about the town remains uncultivated, through the cruel exactions of the government, and the frequent incurſions of the Arabs who are very powerful in theſe parts. The town ſtands on the declivity of a hill on the road to Conſtantina, about 10

leagues

Baja, Baiæ.

leagues from the northern coaſt, and 36 ſouth-weſt from Tunis; and hath the convenience of being well watered. On the higheſt part is a citadel that commands the whole place, but is now of no great ſtrength. The walls were raiſed out of the ruins of the ancient Vacca, and have ſome ancient inſcriptions.

BAJA, a populous town of Hungary, ſeated on the Danube, in E. Long. 19. 50. N. Lat. 46. 40.

BAIÆ, an ancient village of Campania in Italy, between the promontory of Miſenum and Puteoli, on the Sinus Baianus: famous for its natural hot baths, which ſerved the wealthier Romans for the purpoſes both of medicine and pleaſure.—The variety of thoſe baths, the ſoftneſs of its climate, and the beauty of its landſcape, captivated the minds of opulent nobles, whoſe paſſion for bathing knew no bounds. Abundance of linen, and diſuſe of ointments, render the practice leſs neceſſary in modern life; but the ancients performed no exerciſe, engaged in no ſtudy, without previous ablutions, which at Rome required an enormous expence in aqueducts, ſtoves, and attendants: a place therefore, where waters naturally heated to every degree of warmth bubbled ſpontaneouſly out of the ground, in the pleaſanteſt of all ſituations, was ſuch a treaſure as could not be overlooked. Baiæ was this place in the higheſt perfection; its eaſy communication with Rome was alſo a point of great weight. Hither at firſt retired for a temporary relaxation the mighty rulers of the world, to ſtring anew their nerves and revive their ſpirits, fatigued with bloody campaigns and civil conteſts. Their habitations were ſmall and modeſt: but ſoon increaſing luxury added palace to palace with ſuch expedition and ſumptuoſity, that ground was wanting for the vaſt demand: enterpriſing architects, ſupported by infinite wealth, carried their foundations into the ſea, and drove that element back from its ancient limits: it has ſince taken ample revenge, and recovered much more than it ever loſt. From being a place of reſort for a ſeaſon, Baiæ now grew up to a permanent city: whoever found himſelf diſqualified by age, or infirmity, for ſuſtaining any longer an active part on the political theatre; whoever, from an indolent diſpoſition, ſought a place where the pleaſures of a town were combined with the ſweets of a rural life; whoever wiſhed to withdraw from the dangerous neighbourhood of a court, and the baneful eye of informers flocked hither, to enjoy life untainted with fear and trouble. Such affluence of wealthy inhabitants rendered Baiæ as much a miracle of art as it was before of nature; its ſplendor may be inferred from its innumerable ruins, heaps of marbles, moſaics, ſtucco, and other precious fragments of taſte.—It flouriſhed in full glory down to to the days of Theodoric the Goth, but the deſtruction of theſe enchanted palaces followed quickly upon the irruption of the northern conquerors, who overturned the Roman ſyſtem, ſacked and burnt all before them, and deſtroyed or diſperſed the whole race of nobility. Loſs of fortune left the Romans neither the means, nor indeed the thought, of ſupporting ſuch expenſive eſtabliſhments, which can only be enjoyed in perfection during peace and proſperity. No ſooner had opulence withdrawn her hand, than the unbridled ſea ruſhed back upon its old domain; moles and buttreſſes were torn aſunder and waſhed away; whole promontories, with the proud towers that once crowned their brows, were undermined and tumbled headlong into the deep, where, many feet below the ſurface, pavements of ſtreets, foundations of houſes, and maſſes of walls may ſtill be deſcried. Internal commotions of the earth contributed alſo largely to this general devaſtation; mephitic vapours and ſtagnated waters have converted this favourite ſeat of health into the den of peſtilence, at leaſt during the eſtival heats: yet Baiæ in its ruined ſtate, and ſtripped of all its ornaments, ſtill preſents many beautiful and ſtriking ſubjects for the pencil. E. Long. 14. 45. N. Lat. 41. 6.

Swinburn's Sicily.

Bajador ‖ Bajazet.

BAJADOR, a cape on the weſt coaſt of Africa, ſouth of the Canary Iſlands. W. Long. 15. 20. N. Lat. 27. 0.

BAIANUS SINUS, a bay ſo called from *Baiæ*, (Suetonius); *Portus Baiarum*, (Pliny); which was enlarged by Auguſtus, by giving entrance to the ſea into the Lacus Lucrinus, and Averni, ordering it to be called *Portus Julius apud Baias*, (Suetonius). We alſo read *Baianus Lacus* in Tacitus, which ſome interpret the *Lucrinus*. The modern name is *Golfo di Pozzuolo*. From the higheſt point that forms the bay, a large caſtle commands the road, where foreign ſhips of war uſually ride at anchor, the harbour of Naples not being ſpacious enough for the reception of a fleet: here they enjoy good ſheltering, watering, and victualing; but in ſummer riſk the health of their crews, on account of the unwholeſomeneſs of the air.

BAJAZET I. ſultan of the Turks, a renowned warrior, but a tyrant, was conquered by Tamerlane, and expoſed by him in an iron cage; the fate he had deſtined (it is ſaid) for his adverſary if he had been the victor.

The iron cage, however, ſo long and ſo often repeated as a moral leſſon, has been rejected as a fable by modern writers, who ſmile at the vulgar credulity. They appeal to the Perſian hiſtory of Sherefeddin Ali, of which a French verſion has been given, and from which Mr Gibbon has collected the following more ſpecious narrative of this memorable tranſaction. "No ſooner was Timour informed that the captive Ottoman was at the door of his tent, than he graciouſly ſtepped forwards to receive him, ſeated him by his ſide, and mingled with juſt reproaches a ſoothing pity for his rank and misfortune. 'Alas!' ſaid the Emperor, 'the decree of fate is now accompliſhed by your own fault: it is the web which you have woven; the thorns of the tree which yourſelf have planted. I wiſhed to ſpare, and even to aſſiſt, the champion of the Moſlems: you braved our threats, you deſpiſed our friendſhip; you forced us to enter your kingdom with our invincible armies. Behold the event. Had you vanquiſhed, I am not ignorant of the fate which you reſerved for myſelf and my troops. But I diſdain to retaliate: your life and honour are ſecure; and I ſhall expreſs my gratitude to God by my clemency to man.' The royal captive ſhowed ſome ſigns of repentance, accepted the humiliation of a robe of honour, and embraced with tears his ſon Mouſa, who at his requeſt was ſought and found among the captives of the field. The Ottoman princes were lodged in a ſplendid pavilion; and the reſpect of the guards could be ſurpaſſed only by their vigilance. On the arrival of the haram from Bourſa, Timour reſtored the queen Deſpina and her daughter to their father and huſband; but he pi-

Bajazet, Baikal.

onſly required, that the Servian princeſs, who had hitherto been indulged in the profeſſion of Chriſtanity, ſhould embrace without delay the religion of the prophet. In the feaſt of victory, to which Bajazet was invited, the Mogul Emperor placed a crown on his head and a ſceptre in his hand, with a ſolemn aſſurance of reſtoring him with an increaſe of glory to the throne of his anceſtors. But the effect of this promiſe was diſappointed by the ſultan's untimely death: amidſt the care of the moſt ſkilful phyſicians, he expired of an apoplexy at Akſhehr, the Antioch of Piſidia, about nine months after his defeat. The victor dropped a tear over his grave; his body, with royal pomp, was conveyed to the mauſoleum which he had erected at Bourſa; and his ſon Mouſa, after receiving a rich preſent of gold and jewels, of horſes and arms, was inveſted by a patent in red ink with the kingdom of Anatolia.

Such is the portrait of a generous conqueror, which has been extracted from his own memorials, and dedicated to his ſon and grandſon, 19 years after his deceaſe; and, at a time when the truth was remembered by thouſands, a manifeſt falſehood would have implied a ſatire on his real conduct. On the other hand, of the harſh and ignominious treatment of Bajazet there is alſo a variety of evidence. The Turkiſh annals in particular, which have been conſulted or tranſcribed by Leunclavius, Pocock, and Cantemir, unanimouſly deplore the captivity of the iron cage; and ſome credit may be allowed to national hiſtorians, who cannot ſtigmatize the Tartar without uncovering the ſhame of their king and country."—From theſe oppoſite premiſes, Mr Gibbon thinks a fair and moderate concluſion may be deduced. He is ſatisfied that Sherefeddin Ali has faithfully deſcribed the firſt oſtentatious interview, in which the conqueror, whoſe ſpirits were harmoniſed by ſucceſs, affected the character of generoſity. But his mind was inſenſibly alienated by the unſeaſonable arrogance of Bajazet; the complaints of his enemies, the Anatolian princes, were juſt and vehement; and Timour betrayed a deſign of leading his royal captive in triumph to Samarcand. An attempt to facilitate his eſcape by digging a mine under the tent, provoked the Mogul Emperor to impoſe a harſher reſtraint; and in his perpetual marches, an iron cage on a waggon might be invented, not as a wanton inſult, but as a rigorous precaution. Timour had read in ſome fabulous hiſtory a ſimilar treatment of one of his predeceſſors, a king of Perſia; and Bajazet was condemned to repreſent the perſon and expiate the guilt of the Roman Cæſar. But the ſtrength of his mind and body fainted under the trial, and his premature death might without injuſtice be aſcribed to the ſeverity of Timour. He warred not, however, with the dead; a tear and a ſepulchre were all that he could beſtow on a captive who was delivered from his power; and if Mouſa, the ſon of Bajazet, was permitted to reign over the ruins of Bourſa, the greateſt part of the province of Anatolia had been reſtored by the conqueror to their lawful ſovereigns.

BAIKAL, a great lake in Siberia, laying between 52 and 55 degrees north latitude. It is reckoned to be 500 werſts in length; but only 20 or 30 broad, and in ſome places not above 15. It is environed on all ſides by high mountains. In one part of it, which lies near the river Barguſin, it throws up an inflammable ſulphureous liquid called *Maltha*, which the people of the adjacent country burn in their lamps. There are likewiſe ſeveral ſulphureous ſprings near this lake. Its water at a diſtance appears of a ſea-green colour: it is freſh; and ſo clear, that objects may be ſeen in it ſeveral fathoms deep. It does not begin to freeze till near the latter end of December, and thaws again about the beginning of May: from which time till September, a ſhip is ſeldom known to be wrecked on it; but by the high winds which then blow, many ſhipwrecks happen. This lake is called by the neighbouring people *Swiatoie More*, or the *Holy Lake;* and they imagine, that when ſtorms happen on it, they will be preſerved from all danger by complimenting it with the title of *Sea*. When it is frozen over, people travel upon it in the road to China; but they muſt be very ſharp ſhod, otherwiſe they cannot ſtand upon the ice, which is exceedingly ſmooth. Notwithſtanding that the ice on this lake is ſometimes two ells thick, there are ſome open places in it to which tempeſtuous winds will often drive thoſe who are croſſing it, in which caſe they are irrecoverably loſt. The camels that paſs along have a particular kind of ſhoes ſharp at bottom, and the oxen have ſharp irons driven through their hoofs, without which it would be impoſſible for them to paſs. Here are plenty of large ſturgeon and pike; with many ſeals of the black, but none of the ſpotted kind. It contains ſeveral iſlands; and the borders are frequented by black ſables and civet-cats.

Baikal, Bail.

BAIL, Ballium, from the French *bailler*, which comes of the Greek βαλλειν, and ſignifies to deliver into hands), is uſed in our common law for the freeing or ſetting at liberty of one arreſted or impriſoned upon any action, either civil or criminal, on ſurety taken for his appearance at a day and place certain.

The reaſon why it is called *bail*, is becauſe by this means the party reſtrained is delivered into the hands of thoſe that bind themſelves for his forthcoming, in order to a ſafekeeping or protection from priſon; and the end of bail is to ſatisfy the condemnation and coſts, or render the defendant to priſon.

With reſpect to bail in civil caſes, it is to be obſerved, that there is both common and ſpecial bail. Common bail is in actions of ſmall concernment, being called *common*, becauſe any ſureties in that caſe are taken; whereas in cauſes of greater weight, as actions upon bonds, or ſpecialty, &c. where the debt amounts to 10l. *ſpecial* bail or ſurety muſt be taken, ſuch as ſubſidy men at leaſt, and they according to the value.

The commitment of a perſon being only for ſafe cuſtody, wherever bail will anſwer the ſame intention, it ought to be taken; as in moſt of the inferior crimes: but in felonies, and other offences of a capital nature, no bail can be a ſecurity equivalent to the actual cuſtody of the perſon. For what is there that a man may not be induced to forfeit, to ſave his own life? and what ſatisfaction or indemnity is it to the public, to ſeize the effects of them who have bailed a murderer, if the murderer himſelf be ſuffered to eſcape with impunity? Upon a principle ſimilar to which, the Athenian magiſtrates, when they took a ſolemn oath never to keep a citizen in bonds that could give three ſureties

of

Bail. of the ſame quality with himſelf, did it with an exception to ſuch as had embezzled the public money, or been guilty of treaſonable practices.

Bail may be taken either in court, or, in ſome particular caſes, by the ſheriff or other magiſtrate; but moſt uſually by the juſtices of the peace. To refuſe or delay to bail any perſon bailable, is an offence againſt the liberty of the ſubject, in any magiſtrate, by the common law; as well as by the ſtatute Weſtm. 1. 3. Edw. I. c. 15. and the *habeas corpus* act, 31 Car. II. c. 2. And, leſt the intention of the law ſhould be fruſtrated by the juſtices requiring bail to a greater amount than the nature of the caſe demands, it is expreſsly declared by ſtatute 1 W. & M. ſt. 2. c. 1. that exceſſive bail ought not to be required; though what bail ſhall be called *exceſſive*, muſt be left to the courts, on conſidering the circumſtances of the caſe, to determine. And on the other hand, if the magiſtrate takes inſufficient bail he is liable to be fined, if the criminal doth not appear.

In *civil* caſes, every defendant is bailable. But it is otherwiſe in

Criminal matters. Regularly, all offences either againſt the common law or act of parliament, that are below felony, the offender ought to to be admitted to bail unleſs it be prohibited by ſome ſpecial act of parliament.—By the ancient common law, before and ſince the conqueſt, all felonies were bailable, till murder was excepted by ſtatute: ſo that perſons might be admitted to bail almoſt in every caſe. But the ſtatute Weſt. 1. 3 Ed. I. c. 15. takes away the power of bailing in treaſon, and in divers inſtances of felony. The ſtatutes 23 Hen. VI. c. 9. and 1 and 2 Ph. and Mar. c. 13. gave farther regulations in this matter: and upon the whole we may collect, that no juſtices of the peace can bail, 1. Upon an accuſation of treaſon: nor, 2. Of murder: nor 3. In caſe of manſlaughter, if the priſoner be clearly the ſlayer, and not barely ſuſpected to be ſo; or if any indictment be found againſt him; nor 4. Such as, being committed for felony, have broken priſon; becauſe it not only carries a preſumption of guilt, but is alſo ſuperadding one felony to another: 5. Perſons outlawed: 6. Such as have abjured the realm: 7. Perſons taken with the mainour, or in the fact of felony: 8. Perſons charged with Arſon: 9. Excommunicated perſons, taken by writ *de excommunicato capiendo*: all which are clearly not admiſſible to bail by the juſtices. Others are of a dubious nature, as, 10. Thieves openly defamed and known: 11. Perſons charged with other felonies, or manifeſt and enormous offences, not being of good fame: and, 12. Acceſſories to felony, that labour under the ſame want of reputation. Theſe ſeem to be in the diſcretion of the juſtices, whether bailable or not. The laſt claſs are ſuch as *muſt* be bailed upon offering ſufficient ſurety; as, 13. Perſons of good fame, charged with a bare ſuſpicion of manſlaughter, or other infamous homicide; 14. Such perſons being charged with petit larceny or any felony, not before ſpecified: or, 16. With being acceſſory to any felony. Laſtly, it is agreed, that the court of king's bench (or any judge thereof in time of vacation) may bail for any crime whatſoever, be it treaſon, murder, or any other offence, according to the circumſtances of the caſe. And herein the wiſdom of the law is very manifeſt. To allow bail to be taken commonly for ſuch enormous crimes, would greatly tend to elude the public juſtice: and yet there are caſes, though they rarely happen, in which it would be hard and unjuſt to confine a man in priſon, though accuſed even of the greateſt offence. The law has therefore provided one court, and only one, which has a diſcretionary power of bailing in any caſe: except only, even to this high juriſdiction, and of courſe to all inferior ones, ſuch perſons as are committed by either houſe of parliament, ſo long as the ſeſſion laſts; or ſuch as are committed for contempts by any of the king's ſuperior courts of juſtice. See LAW, Part III. N° xxxvi. 42. Bail. Bailiff.

Clerk of the BAILS, is an officer belonging to the court of the King's Bench: he files the bail-pieces taken in that court, and attends for that purpoſe.

BAIL, or BALE, in the ſea-language. The ſeamen call throwing the water by hand out of the ſhip's or boat's hold, *bailing*. They alſo call thoſe hoops that bear up the tilt of a boat, its *bails*.

BAILIE, in Scots law, a judge anciently appointed by the king over ſuch lands not erected into a regality as happened to fall to the crown by forfeiture or otherwiſe, now aboliſhed. It is alſo the name of a magiſtrate in royal boroughs, and of the judge appointed by a baron over lands erected into a barony. See LAW, Part III. N° cxviii. 6, 7.

BAILIFF *(ballivus)*, from the French word *bayliff*, that is, *præfectus provinciæ*: and as the names, ſo the office itſelf was anſwerable to that of France; where there are eight parliaments, which are high courts from whence there lies no appeal, and within the precincts of the ſeveral parts of that kingdom which belong to each parliament there are ſeveral provinces to which juſtice is adminiſtered by certain officers called *bailiffs*; and in England there are ſeveral counties in which juſtice hath been adminiſtered to the inhabitants by the officer who is now called *ſheriff* or *viſcount* (one of which names deſcends from the Saxons, the other from the Normans); and though the ſheriff is not called *bailiff*, yet it is probable that was one of his names alſo, becauſe the county is often called *balliva*. And in the ſtatute of Magna Charta, cap. 28. and 14 Ed. 3. c. 9. the word *bailiff* ſeems to compriſe as well ſheriffs as bailiffs of hundreds. As the realm is divided into counties, ſo every county is divided into hundreds; within which in ancient times the people had juſtice miniſtered to them by the officers of every hundred. But now the hundred courts, except certain franchiſes, are ſwallowed in the county-courts; and the bailiff's name and office is grown into contempt, they being generally officers to ſerve writs, &c. within their liberties. Though, in other reſpects, the name is ſtill in good eſteem: for the chief magiſtrates in divers town are called *bailiffs* or *bailies*; and ſometimes the perſons to whom the king's caſtles are committed are termed *bailiffs*, as the *bailiff of Dover caſtle*, &c.

Of the ordinary bailiffs there are ſeveral ſorts, *viz.* ſheriff's bailiffs, bailiffs of liberties, &c.

Sheriff's bailiffs, or ſheriff's officers, are either bailiffs of hundreds, or ſpecial bailiffs. Bailiffs of hundreds are officers appointed over thoſe reſpective diſtricts by the ſheriffs, to collect fines therein; to ſummon juries; to attend the judges and juſtices at the aſſiſes, and quarter-ſeſſions; and alſo to execute writs and proceſs in

Bailiff
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Baillet.

the ſeveral hundreds. But as theſe are generally plain men, and not thoroughly ſkilful in this latter part of their office, that of ſerving writs, and making arreſts and executions, it is now uſual to join ſpecial bailiffs with them; who are generally mean perſons employed by the ſheriffs on account only of their adroitneſs and dexterity in hunting and ſeizing of their prey.

Bailiffs of liberties are thoſe bailiffs who are appointed by every lord within his liberty, to execute proceſs and do ſuch offices therein as the bailiff errant doth at large in the county; but bailiffs errant or itinerant, to go up and down the county to ſerve proceſs, are out of uſe.

There are alſo bailiffs of foreſts, and bailiffs of manors, who direct huſbandry, fell trees, gather rents, pay quit-rents, &c.

Water BAILIFF, an officer appointed in all port-towns, for the ſearching of ſhips, gathering the toll for anchorage, &c. and arreſting perſons for debt, &c. on the water.

BAILII (David), painter of perſpective views and portraits, was the ſon of Peter Bailii, an artiſt of ſome note; and was born at Leyden in 1584. From his father he learned to draw and deſign: but he was afterwards placed under the care of Adrian Verburg, and continued with him for ſome time; and when he quitted that maſter, he ſtudied to much greater advantage with Cornelius Vandervoort, an excellent portrait painter, and with him he ſpent above ſix years. As Vandervoort poſſeſſed many capital paintings of ſome great maſters, Bailii, for his own improvement, copied them with critical care and obſervation; and particularly copied one perſpective view of the inſide of a church, originally painted by Stenwyck, which he finiſhed with ſuch accuracy, that even Stenwyck himſelf could ſcarce determine which was the original, or which the copy, when both were placed before him. He travelled through ſeveral parts of Italy, to ſee the works of the celebrated maſters of that country, and for a few years reſided at Rome; and abroad, as well as in his own country, the correctneſs of his drawing, and the delicate handling and finiſhing of his pictures, procured him employment, admirers, and friends. In the latter part of his life he diſcontinued painting, and only drew portraits on vellum with a pen, which he heightened with black lead, and gave them wonderful force and roundneſs. He died in 1638.

BAILIWICK, that liberty which is exempted from the ſheriff of the county; over which liberty the lord thereof appoints his own bailiff, with the like power within his precinct as an under ſheriff exerciſes under the ſheriff of the county: Or it ſignifies the precinct of a bailiff, or the place within which his juriſdiction is terminated.

BAILLET (Adrian), a very learned French writer and critic, born in 1649, at the village of Neuville near Beauvais in Picardy. His parents were too poor to give him a proper education, which however he obtained by the favour of the Biſhop of Beauvais, who afterwards preſented him with a ſmall vicarage. In 1680, he was appointed librarian to M. de Lamoignon, advocate general to the parliament of Paris; of whoſe library he made a copious index in 35 vols folio, all written with his own hand. He died in 1706, after writing many works, the principal of which are, *A Hiſtory of Holland from* 1609, *to the peace of Nimeguen in* 1679, 4 vols 12mo; *Lives of the Saints*, 3 vols folio, which he profeſſed to have purged from fables; *Jugemens des Sçavans*, which he extended to 9 vols 12mo; and *The Life of Des Cartes*, 2 vols 4to, which he abridged, and reduced to 1 vol. 12mo.

Bailleul
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Bainbridge

BAILLEUL, a town of France, in the earldom of Flanders, formerly very ſtrong, but now without any fortifications. It has been ſeveral times burnt by accident, and contains now only about 500 houſes. E. Long. 2. 55. N. Lat. 40. 35.

BAILMENT, in law, is a delivery of goods in truſt, upon a contract, expreſſed or implied, that the truſt ſhall be faithfully executed on the part of the bailee. As if cloth be delivered, or (in our legal dialect) bailed, to a taylor to make a ſuit of clothes, he has it upon an implied contract to render it again when made, and that in a workmanly manner. If money or goods be delivered to a common carrier, to convey from Oxford to London, or from Glaſgow to Edinburgh, &c. he is under a contract in law to pay, or carry them to the perſon appointed. If a horſe or other goods be delivered to an inn-keeper or his ſervants, he is bound to keep them ſafely, and reſtore them when his gueſt leaves the houſe. If a man takes in a horſe, or other cattle, to graze and depaſture in his grounds, which the law calls *agiſtment*, he takes them upon an implied contract to return them on demand to the owner. If a pawnbroker receives plate or jewels as a pledge or ſecurity for the repayment of money lent thereon at a day certain, he has them upon an expreſs contract or condition to reſtore them if the pledger performs his part by redeeming them in due time: for the due execution of which contract, many uſeful regulations are made by ſtatute 30 Geo. II. c. 24. And ſo, if a landlord diſtrains goods for rent, or a pariſh officer for taxes, theſe for a time are only a pledge in the hands of the diſtrainers, and they are bound by an implied contract in law to reſtore them on payment of the debt, duty, and expences, before the time of ſale; or when ſold, to render back the overplus. If a friend delivers any thing to his friend to keep for him, the receiver is bound to reſtore it on demand: and it was formerly held, that in the mean time he was anſwerable for any damage or loſs it might ſuſtain, whether by accident or otherwiſe; unleſs he expreſsly undertook to keep it only with the ſame care as his own goods, and then he ſhould not be anſwerable for theft or other accidents. But now the law ſeems to be ſettled on a much more rational footing; that ſuch a general bailment will not charge the bailee with any loſs, unleſs it happens by groſs neglect, which is conſtrued to be an evidence of fraud: but if the bailee undertakes ſpecially to keep the goods ſafely and ſecurely, he is bound to anſwer all perils and damages that may befal them for want of the ſame care with which a prudent man would keep his own.

BAILO; thus they ſtyle at Conſtantinople the ambaſſador of the republic of Venice, who reſides at the Porte. This miniſter, beſides his political charge, acts there the part of a conſul of Venice.

BAINBRIDGE (Dr John), an eminent phyſician and aſtronomer, born at Aſhby de la Zonche in Leiceſterſhire, in 1582. He taught a grammar ſchool for ſome years, and practiſed phyſic, employing his leiſure hours

Baiocao ‖ Baiting.

hours in aſtronomy, which was his favourite ſtudy: at length he removed to London, was admitted a fellow of the college of phyſicians, and raiſed his character by his deſcription of the comet in 1618. The next year Sir Henry Savile appointed him his firſt profeſſor of aſtronomy at Oxford; and the maſters and fellows of Merton-college made him firſt junior, and then ſuperior, reader of Linacre's lecture. He died in 1643, having written many works, ſome of which have never been publiſhed: but the MSS. are preſerved in the library of Trinity-college, Dublin.

BAIOCAO, a copper-coin, current at Rome, and throughout the whole ſtate of the church, ten of which make a Julio, and an hundred a Roman crown.

BAIRAM, or Beiram, a Turkiſh word which ſignifies a ſolemn feaſt. The Mahometans have two Bairams, the *Great* and the *Little*. The *Little* Bairam is properly that held at the cloſe of the faſt Ramazan, beginning with the firſt full moon in the following month Shawal. This is called in Arabic *Id al Fetz, or the Feaſt of breaking the faſt*; by European writers, *the Turkiſh Eaſter*, becauſe it ſucceeds Ramazan, which is their Lent, more uſually the *Great Bairam*, becauſe obſerved with great ceremony and rejoicing at Conſtantinople, and through Turkey, for three days, and in Perſia for five or ſix days, at leaſt by the common people, to make themſelves amends for the mortification of the preceding month.—The feaſt commencing with the new moon, the Mahometans are very ſcrupulous in obſerving the time when the new moon commences; to which purpoſe, obſervers are ſent to the tops of the higheſt mountains, who the moment they ſpy the appearance of a new moon, run to the city, and proclaim *Muzhdaluk*, "welcome news;" as it is the ſignal for beginning the feſtivity.—The *Great Bairam*, is properly that held by the pilgrims at Mecca, commencing on the tenth of Dhu Ihajia, when the victims are ſlain, and laſting three days. This is called by the Arabs, *Id al adha*, that is, *the feaſt of ſacrifice*, as being celebrated in memory of the ſacrifice of Abram, whoſe ſon God redeemed with a great victim. By European writers it is called the *Leſſer Bairam*, as being leſs taken notice of by the generality of the people, who are not ſtruck with it, becauſe the ceremonies, it is obſerved withal, are performed at Mecca, the only ſcene of the ſolemnity.——On the feaſt of Bairam, after throwing little ſtones, one after another, into the valley of Mina, they uſually kill one or more ſheep, ſome a goat, bullock, or even a camel; and after giving a part thereof to the poor, eat the reſt with their friends. After this, they ſhave themſelves. The ſecond is a day of reſt. On the third, they ſet out on their return home.

BAIROUT. See Beeroot.

BAIT, among fiſhermen, implies a ſubſtance proper to be faſtened to a hook, in order to catch the different ſorts of fiſh. See Fishing.

BAITING, the act of ſmaller or weaker beaſts attacking and haraſſing greater and ſtronger. In this ſenſe we hear of the baiting of bulls or bears by maſtiffs, or bull-dogs with ſhort noſes, that they may take the better hold.

Utility is pled in juſtification of *bull-baiting*. This animal is rarely killed without being firſt baited; the chaffing and exerciſe whereof makes his fleſh tenderer and more digeſtible. In reality, it diſpoſes it for putrefaction; ſo that, unleſs taken in time, baited fleſh is ſoon loſt. But a ſpirit of barbariſm had the greateſt ſhare in ſupporting the ſport: bulls are kept on purpoſe, and exhibited as ſtanding ſpectacles for the public entertainment. The poor beaſts have not fair play: they are not only tied down to a ſtake, with a collar about their necks, and a ſhort rope, which gives them not above four or five yards play; but they are diſarmed too, and the tips of their horns cut off, or covered with leather, to prevent their hurting the dogs. In this ſport, the chief aim of the dog is to catch the bull by the noſe, and hold him down; to which end, he will even creep on his belly: the bull's aim, on the contrary, is, with equal induſtry, to defend his noſe; in order to which, he thruſts it cloſe to the ground, where his horns are alſo in readineſs to toſs the dog.—Bull-baiting was firſt introduced into England as an amuſement in the reign of king John, about 1209.

Bajulus ‖ Baker.

BAJULUS, an ancient officer in the court of the Greek emperors. There were ſeveral degrees of bajuli; as, the grand *Bajulus*, who was preceptor to the emperor; and the ſimple *bajuli*, who were ſub-preceptors. The word is derived from the Latin verb *bajulare*, "to carry or bear a thing on the arms or the ſhoulders;" and the origin of the office is thus traced by antiquaries. Children, and eſpecially thoſe of condition, had anciently, beſides their nurſe, a woman called *gerula*, as appears from ſeveral paſſages of Tertullian; when weaned, or ready to be weaned, they had men to carry them about and take care of them, who were called *geruli* and *bajuli*, *a gerendo et bajulando*. Hence it is, that governors of princes and great lords, were ſtill denominated *bajuli*, and their charge or government *bajulatio*, even after their pupils were grown too big to be carried about. The word paſſed in the ſame ſenſe into Greece.

Bajulus is alſo uſed by Latin writers in the ſeveral other ſenſes wherein Bailiff is uſed among us.

Bajulus was alſo the name of a conventual officer in the ancient monaſteries, to whom belonged the charge of gathering and diſtributing the money and legacies left for maſſes and obits; whence he was alſo denominated *bajulus obituum novorum*.

BAKAN, a large and handſome town of Aſia in the Eaſt Indies, in the kingdom of Ava. E. Long. 98. 0. N. Lat. 19. 35.

BAKER (Sir Richard), author of the Chronicle of the kings of England, was born at Siſſingherſt, in Kent, about the year 1568. After going through the uſual courſe of academical learning at Hart-hall, in Oxford, he travelled into foreign parts; and upon his return home was created maſter of arts, and ſoon after, in 1603, received from king James I. the honour of knighthood. In 1620, he was high ſheriff of Oxfordſhire; but engaging to pay ſome of the debts of his wife's family, he was reduced to poverty, and obliged to betake himſelf for ſhelter to the Fleet priſon, where he compoſed ſeveral books; among which are, 1. Meditations and Diſquiſitions on the Lord's Prayer. 2. Meditations, &c. on ſeveral of the Pſalms of David. 3. Meditations and Prayers upon the ſeven days of the Week. 4. *Cato Variegatus*, or Cato's Moral Diſtichs varied, &c.—Mr Granger obſerves, that his Chronicle of the Kings of England was ever more eſteemed

by

Baker. by readers of a lower claſs than by ſuch as had a critical knowledge of hiſtory. The language of it was, in this reign, called polite; and it long maintained its reputation, eſpecially among country gentlemen. The author ſeems to have been ſometimes more ſtudious to pleaſe than to inform, and with that view to have ſacrificed even chronology itſelf to method. In 1658, Edward Philips, nephew to Milton, publiſhed a third edition of this work, with the addition of the reign of Charles I. It has been ſeveral times reprinted ſince, and is now carried as low as the reign of George I. Sir Richard alſo tranſlated ſeveral works from the French and Italian; and died very poor, in the Fleet priſon, on the 18th of February 1645.

Baker (Thomas), an eminent mathematician, was born at Ilton in Somerſetſhire, about the year 1625, and entered at Magdalen-hall, Oxon, in 1640; after which he was vicar of biſhop's-Nymmet, in Devonſhire, where he wrote The Geometrical Key, or the Gate of Equations unlocked; by which he gained a conſiderable reputation. A little before his death, the members of the Royal Society ſent him ſome mathematical queries, to which he returned ſo ſatisfactory an anſwer, that they preſented him a medal, with an inſcription full of honour and reſpect. He died at Biſhop's-Nymmet on the 5th of June 1690.

Baker (Thomas), a very ingenious and learned antiquary, deſcended from a family ancient and well eſteemed, diſtinguiſhed by its loyalty and affection for the crown, was born at Crook in 1656. He was educated at the free ſchool at Durham, and thence removed to St John's college Cambridge in 1674. He proceeded B. A. 1677; M. A. 1681; was elected fellow March 1679-80; ordained deacon by Biſhop Compton of London December 20. 1685; prieſt by Biſhop Barlow of Lincoln December 19. 1686. Dr Watſon, tutor of the college, who was nominated, but not yet conſecrated biſhop of St David's, offered to take him for his chaplain, which he declined, probably on the proſpect of a like offer from Lord Crew biſhop of Durham, which he ſoon after accepted. His Lordſhip collated him to the rectory of Long-Newton in his dioceſe, and the ſame county, June 1687; and, as Dr Grey was informed by ſome of the biſhop's family, intended to have given him that of Sedgefield, worth L. 600 or L. 700 a-year, with a golden prebend, had he not incurred his diſpleaſure and left his family for refuſing to read King James II.'s declaration for liberty of conſcience. The biſhop, who diſgraced him for this refuſal, and was excepted out of King William's pardon, took the oaths to that king, and kept his biſhopric till his death. Mr Baker reſigned Long-Newton Auguſt 1. 1690, refuſing to take the oaths; and retired to his fellowſhip at St John's, in which he was protected till January 20, 1716-17, when, with one and twenty others, he was diſpoſſeſſed of it. After the paſſing the Regiſtering Act 1723, he was deſired to regiſter his annuity of L. 40, which the laſt act required before it was amended and explained. Though this annuity, left him by his father for his fortune, with L. 20 *per annum* out of his collieries by his elder brother from the day of his death Auguſt 1699, for the remaining part of the leaſe, which determined at Whitſuntide 1723, was now his whole ſubſiſtence, he could not be prevailed on to ſecure himſelf againſt the act. He retained a lively reſentment of his deprivations; and wrote himſelf in all his books, as well as in thoſe which he gave to the college library, *ſocius ejectus*, and in ſome *ejectus rector*. He continued to reſide in the college as commoner-maſter till his death, which happened July 2. 1740, of a paralytic ſtroke, being found on the floor of his chamber. In the afternoon of June 29, being alone in his chamber, he was ſtruck with a ſlight apoplectic fit; which abating a little, he recovered his ſenſes, and knew all about him, who were his nephew Burton, Drs Bedford and Heberden. He ſeemed perfectly ſatisfied and reſigned; and when Dr Bedford deſired him to take ſome medicine then ordered, he declined it, ſaying, he would only take his uſual ſuſtenance, which his bed-maker knew the times and quantities of giving: he was thankful for the affection and care his friends ſhowed him; but, hoping the time of his diſſolution was at hand, would by no means endeavour to retard it. His diſorder increaſed, and the third day from this ſeizure he departed. Being appointed one of the executors of his eldeſt brother's will, by which a large ſum was bequeathed to pious uſes, he prevailed on the other two executors, who were his other brother Francis and the hon. Charles Montague, to lay out L. 1310 of the money upon an eſtate to be ſettled upon St John's college for ſix exhibitioners. He likewiſe gave the college L. 100 for the conſideration of L. 6 a-year (then only legal intereſt) for his life; and to the library ſeveral choice books, both printed and MS. medals, and coins; beſides what he left to it by his will; which were "all ſuch books, printed and MS. as he had, and were wanting there." All that Mr Baker printed was, 1. Reflections on Learning, ſhowing the inſufficiency thereof in its ſeveral particulars, in order to evince the uſefulneſs and neceſſity of Revelation, Lond. 1709-10" (which went through eight editions, and Mr Boſwell, in his "Method of Study," ranks it among the Engliſh claſſics for purity of ſtyle); and, 2. The Preface to Biſhop Fiſher's Funeral Sermon for Margaret Counteſs of Richmond and Derby, 1708;" both without his name. Dr Grey had the original MS. of both in his own hands. The latter piece is a ſufficient ſpecimen of the editor's ſkill in antiquities to make us regret that he did not live to publiſh his "Hiſtory of St John's college, from the foundation of old St John's houſe to the preſent time; with ſome occaſional and incidental account of the affairs of the univerſity, and of ſuch private colleges as held communication or intercourſe with the old houſe or college: collected principally from MSS. and carried on through a ſucceſſion of maſters to the end of Biſhop Gunning's maſterſhip, 1670." The original, fit for the preſs, is among the Harleian MSS. N° 7028. His MS. collections relative to the hiſtory and antiquities of the univerſity of Cambridge, amounting to 39 volumes in folio and three in quarto, are divided between the Britiſh Muſeum and the public library at Cambridge; the former poſſeſſes 23 volumes, which he bequeathed to the Earl of Oxford, his friend and patron; the latter 16 in folio, and three in quarto, which he bequeathed to the univerſity. Dr Knight ſtyles him "the greateſt maſter of the antiquities of this our univerſity;" and Hearne ſays, *Optandum eſt ut ſua quoque collectanea de antiquitatibus Cantabrigienſibus juris faciat publici Cl. Backerus, quippe qui eruditione*

Baker.

Baker. *tione ſumma judicioque acri et ſubacto polleat.* Mr Baker intended ſomething like an *Athenæ Cantabrigienſes*, on the plan of the *Athenæ Oxonienſes*.

BAKER (Henry), an ingenious and diligent naturaliſt, was born in Fleet-ſtreet London, either near the end of the laſt, or very early in the beginning of the preſent century. His father's profeſſion is not known; but his mother was, in her time, a midwife of great practice. He was brought up under an eminent bookſeller who preceded the elder Dodſley to the buſineſs of a bookſeller; in which, however, he appears not to have engaged at all after his apprenticeſhip; or, if he did, it was ſoon relinquiſhed by him: for though it was in his power to have drawn away all his maſter's beſt cuſtomers, he would not ſet up againſt him. Mr Baker being of a philoſophical turn of mind, and having diligently attended to the methods which might be practicable and uſeful in the cure of ſtammering, and eſpecially in teaching deaf and dumb perſons to ſpeak, he made this the employment of his life. In the proſecution of ſo valuable and difficult an undertaking, he was very ſucceſsful; and ſeveral of his pupils, who are ſtill living, bear teſtimony to the ability and good effect of his inſtructions. He married Sophia, youngeſt daughter of the famous Daniel Defoe, who brought him two ſons, both of whom he ſurvived. On the 29th of January 1740, Mr Baker was elected a fellow of the Society of Antiquaries; and, on the 12th of March following, the ſame honour was conferred upon him by the Royal Society. In 1744, Sir Godfrey Copley's gold medal was beſtowed upon him, for having, by his microſcopical experiments on the cryſtallizations and configurations of ſaline particles, produced the moſt extraordinary diſcovery during that year. Having led a very uſeful and honourable life, he died at his apartments in the Strand on the 25th of November 1774, being then above 70 years of age. His wife had been dead ſome time before; and he only left one grandſon, William Baker, who was born February 17. 1763, and to whom, on his living to the age of 21, he bequeathed the bulk of his fortune, which he had acquired by his profeſſion of teaching deaf and dumb perſons to ſpeak. His furniture, printed books (but not MSS.), curioſities, and collections of every ſort, he directed ſhould be ſold, which was accordingly done. His fine collection of native and foreign foſſils, petrifactions, ſhells, corals, vegetables, ores, &c. with ſome antiquities and other curioſities, were ſold by auction March 13. 1775, and the nine following days. He was buried, as he deſired, in an unexpenſive manner, in the church-yard of St Mary-le-ſtrand; within which church, on the ſouth wall he ordered a ſmall tablet to be erected to his memory. "An inſcription for it (he ſaid) would probably be found among his papers; if not, he hoped ſome learned friend would write one agreeably to truth." This friendly office, however, remains as yet to be performed. Mr. Baker was a conſtant and uſeful attendant at the meetings of the Royal and Antiquarian Societies, and in both was frequently choſen one of the council. He was peculiarly attentive to all the new improvements which were made in natural ſcience, and very ſolicitous for the proſecution of them. Several of his communications are printed in the Philoſophical Tranſactions; and, beſides the papers written by himſelf, he was the means, by his extenſive correſpondence, of conveying to the Society the intelligence and obſervations of other inquiſitive and philoſophical men, both at home and abroad. The Society for the encouragement of arts, manufactures, and commerce, is under ſingular obligations to our worthy naturaliſt. As he was one of the earlieſt members of it, ſo he contributed in no ſmall degree to its riſe and eſtabliſhment. At its firſt inſtitution he officiated for ſome time *gratis* as ſecretary. He was many years chairman of the committee of accounts; and he took an active part in the general deliberations of the Society. He drew up a ſhort account of the original of this ſociety, and of the concern he himſelf had in forming it; which was read before the ſociety of antiquaries, and would be a pleaſing preſent to the public. Mr Baker was a poetical writer in the early part of his life. His *Invocation of Health* got abroad without his knowledge; but was reprinted by himſelf in his *Original Poems, ſerious and humorous*, Part I. 8vo, 1725. Part II. came out in 1726. Among theſe poems are ſome tales as witty and as looſe as Prior's. He was the author likewiſe of *The Univerſe*, a poem intended to reſtrain the pride of man; which has been ſeveral times reprinted. His account of the water polype, which was originally publiſhed in the Philoſophical Tranſactions, was afterwards enlarged into a ſeparate treatiſe, and hath gone through ſeveral editions. But his principal publications are, *The Microſcope made Eaſy*, and *Employment for the Microſcope*. The firſt of theſe, which was originally publiſhed in 1742, or 1743, hath gone through ſix editions. The ſecond edition of the other, which to ſay the leaſt of it, is equally pleaſing and inſtructive, appeared in 1764. Theſe treatiſes, and eſpecially the latter, contain the moſt curious and important of the obſervations and experiments which Mr Baker either laid before the Royal Society or publiſhed ſeparately. It has been ſaid of Mr Baker that *he was a philoſopher in little things*. If it was intended by this language to leſſen his reputation, there is no propriety in the ſtricture. He was an intelligent, upright, and benevolent man, much reſpected by thoſe who knew him beſt. His friends were the friends of ſcience and virtue: and it will always be remembered by his cotemporaries, that no one was more ready than himſelf to aſſiſt thoſe with whom he was converſant in their various reſearches and endeavours for the advancement of knowledge and the benefit of ſociety. Baker.

BAKER (David-Erſkine), ſon to the former, was a young man of genius and learning. Having been adopted by an uncle, who was a ſilk-throwſter in Spital-fields, he ſucceeded him in the buſineſs; but wanted the prudence and attention which are neceſſary to ſecure proſperity in trade. He married the daughter of Mr Clendon, a reverend empiric. Like his father, he was both a philoſopher and a poet; and wrote ſeveral occaſional poems in the periodical collections, ſome of which were much admired at the time; but ſo violent was his turn for dramatic performance, that he repeatedly engaged with the loweſt ſtrolling companies, in ſpite of every effort of his father reclaim him. The public was indebted to him for "The Companion to the

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the Play-houſe," in two volumes, 1764, 12mo; a work which, though imperfect, had conſiderable merit, and ſhowed that he poſſeſſed a very extenſive knowledge of our dramatic authors; and which has ſince (under the title of "Biographia Dramatica") been conſiderably improved by the attention of a gentleman in every reſpect well qualified for the undertaking.

BAKER, a perſon whoſe occupation or buſineſs is to bake bread. See the articles BAKING and BREAD.

The learned are in great doubt about the time when baking firſt became a particular profeſſion and bakers were introduced. It is however generally agreed, that they had their riſe in the eaſt, and paſſed from Greece to Italy after the war with Pyrrhus, about the year of Rome 583. Till which time every houſewife was her own baker; for the word *piſtor*, which we find in Roman authors before that time, ſignified a perſon who ground or pounded the grain in a mill or mortar to prepare it for baking, as Varro obſerves. According to Athenæus, the Cappadocians were the moſt applauded bakers, after them the Lydians, then the Phœnicians.—To the foreign bakers brought into Rome, were added a number of freed-men, who were incorporated into a body, or as they called it, a *college*; from which neither they nor their children were allowed to withdraw. They held their effects in common, and could not diſpoſe of any part of them. Each bake-houſe had a patronus, who had the ſuperintendency thereof; and theſe patroni elected one out of their number each year, who had ſuperintendence over all the reſt, and the care of the college. Out of the body of the bakers were every now and then one admitted among the ſenators.—To preſerve honour and honeſty in the college of bakers, they were expreſsly prohibited all alliance with comedians and gladiators; each had his ſhop or bake-houſe, and they were diſtributed into fourteen regions of the city. They were excuſed from guardianſhips and other offices, which might divert them from their employment.—By our own ſtatutes bakers are declared not to be handicrafts. No man for uſing the myſteries or ſciences of baking, brewing, ſurgery, or writing, ſhall be interpreted a handicraft. The bakers were a brotherhood in England before the year 1155, in the reign of king Henry II. though the white bakers were not incorporated till 1337, by king Edward III. and the brown bakers not till 1621, in king James I.'s time. Their hall is in Harp-lane, Thames-ſtreet; and their court-day on the firſt Monday of the month.—They make the 19th company; and conſiſt of a warden, 4 maſters, 30 aſſiſtants, and 140 men on the livery, beſides the commonalty.—The French had formerly a great baker, *grand panetier de France*, who had the ſuperintendency of all the bakers of Paris. But ſince the beginning of this century, they have been put under the juriſdiction of the lieutenant-general *de police*. In ſome provinces of France, the lord is the only baker in his ſeigneury; keeping a public oven, to which all the tenants are obliged to bring their bread. This right is called *furnagium*, or *furnaticum*, and makes part of the *bannalite*.

BAKEWELL, a pretty large town of Derbyſhire, in England, ſeated on the river Wye, on the North-ſide of the Peak. It has a conſiderable trade in lead. W. Long. 2. 30. N. Lat. 55. 15.

BAKING, the art of preparing bread, or reducing meals of any kind, whether ſimple or compound, into bread. See the article BREAD. Baking.

The various forms of baking among us may be reduced into two, the one for unleavened, the other for leavened bread. For the firſt, the chief is manchet-baking; the proceſs whereof is as follows. The meal, ground and boulted, is put into a trough; and to every buſhel are poured in about three pints of warm ale, with barm and ſalt to ſeaſon it. This is kneaded well together, with the hands through the brake; or, for want thereof, with the feet, through a cloth: after which, having lain an hour to ſwell, it is moulded into manchets; which, ſcorched in the middle, and pricked up at top, to give room to riſe, are baked in the oven by a gentle fire.—For the ſecond, ſometimes called *cheat-bread baking*, it is thus: Some leaven (ſaved from a former batch) filled with ſalt, laid up to ſour, and at length diſſolved in water, is ſtrained through a cloth into a hole made in the middle of the heap of meal in the trough; then it is worked with ſome of the flour into a moderate conſiſtence: this is covered up with meal, where it lies all night; and in the morning the whole heap is ſtirred up, and mixed with a little warm water, barm, and ſalt, by which it is ſeaſoned, ſoftened, and brought to an even leaven: it is then kneaded, moulded, and baked, as before.

Method of raiſing a buſhel of flour, with a tea-ſpoonful of barm; by James Stone, of Amport, in Hampſhire.—Suppoſe you want to bake a buſhel of flour, and have but one tea-ſpoonful of barm. Put your flour into your kneading-trough or trendle; then take about three quarters of a pint of warm water, and take the tea-ſpoonful of thick ſteady barm and put it into the water, ſtir it until it is thoroughly mixed with the water: then make a hole in the middle of the flour large enough to contain two gallons of water, pour in your ſmall quantity; then take a ſtick about two feet long, (which you may keep for that purpoſe), and ſtir in ſome of the flour, until it is as thick as you would make batter for a pudding: then ſtrew ſome of the dry flour over it, and go about your uſual buſineſs for about an hour: then take about a quart of warm water more, and pour in; for in one hour you will find that ſmall quantity raiſed ſo, that it will break through the dry flour which you ſhook over it; and when you have poured in the quart of warm water, take your ſtick as before, and ſtir in ſome more flour, until it is as thick as before; then ſhake ſome more dry flour over it, and leave it for two hours more, and then you will find it riſe and break through the dry flour again; then you may add three quarts or a gallon of water more, and ſtir it in the flour and make it as thick as at firſt, and cover it with dry flour again; in about three or four hours more you may mix up your dough, and then cover it up warm; and in four or five hours more you may put it into the oven, and you will have as light bread as though you had put a pint of barm. It does not take above a quarter of an hour more time than the uſual way of baking, for there is no time loſt but that of adding water three or four times.

The author of this method aſſures us, that he conſtantly bakes this way in the morning about ſix or ſeven o'clock, puts the flour out, and puts this ſmall quantity of barm into the before-mentioned quantity of water, in an hour's time ſome more, in two hours more

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a greater quantity, about noon makes up the dough, and about ſix in the evening it is put into the oven, and he has always good bread, never heavy nor bitter.

When you find, he ſays, your body of flour ſpunged large enough, before you put in the reſt of your water, you ſhould, with both your hands, mix that which is ſpunged and the dry flour altogether, and then add the remainder of warm water, and your dough will riſe the better and eaſier.

The reaſon he aſſigns why people make heavy bread is, not becauſe they have not barm enough, but becauſe they do not know that barm is the ſame to flour as fire is to fuel; that, as a ſpark of fire will kindle a large body by only blowing of it up, ſo will a thimble-full of barm, by adding of warm water, raiſe or ſpunge any body of flour; for warm water gives freſh life to that which is before at work: ſo that the reaſon of making bread heavy is, becauſe the body ſpunged is not large enough, but was made up and put into the oven before it was ripe.

In regard to the difference of ſeaſons, he preſcribes, that in the ſummer you ſhould put your water blood-warm; and in winter, in cold froſty weather, as warm as you can bear your hand in it without making it ſmart; being ſure you cover up your dough very warm in the winter, and your covering of it with dry flour every time you add warm water, will keep in the heat; when you have added ſix or eight quarts of warm water, as before mentioned, in ſuch a gradual way, you will find all that body of flour which is mixed with the warm water, by virtue of that one tea-ſpoonful of barm, brought into great agitation, waxing or fermenting; for it is to the flour what the ſpirit is to the body, it ſoon fills it with motion.

BAKOU, or BAKU, a town of Perſia, in the province of Shirvan, ſituated at the extremity of the Gulf of Ghilan on the Caſpian Sea. It is eſteemed the moſt commodious haven in this ſea, as veſſels may there ride ſecurely at anchor in ſeven fathom water; but the number of ſhoals, iſlands, and ſand-banks, render the entrance in ſome places extremely difficult and dangerous, particularly to the Ruſſians, who are not very expert ſailors. Baku is a fortreſs ſurrounded with high brick walls; its inhabitants, like thoſe of Derbent, are Perſians, Tartars, and a few Armenian merchants. The principal articles of exportation which ſupport the trade of this place are naphtha, and the fineſt rock ſalt, of both which there are mines on the eaſt ſide of the bay. The inhabitants cultivate ſaffron and the cotton tree, but not to any conſiderable advantage. The trade of Baku, though more valuable than that of Derbent, is ſtill conſiderable, and chiefly carried on with Shamakee, from whence it draws raw ſilk and ſilken ſtuffs. A Ruſſian conſul is reſident at this place. In 1777 Baku belonged to Melik-Mehmed, who was tributary to Feth Ali, khan of Kuba; the latter poſſeſſed the whole province of Shirvan, and was the moſt powerful prince, next to the khan of Ghilan, upon the coaſt of the Caſpian. Before we quit the province of Shirvan, it may not be improper to mention its capital, the inland town of Shamakee, which is only 66 miles from Baku, and ſupplies that port with raw ſilk and ſilken ſtuffs. It owed its former commercial importance to the ſilk which is cultivated in the neighbouring diſtrict; this rich production ſtill preſerves the town from ruin; though its traffic is greatly reduced by the exorbitant exactions of the khan of Kuba. Formerly the Ruſſians had a factory at this place; and it was alſo crowded with Turkiſh and Greek merchants; but at preſent there are only a few Armenian and Indian traders. The inhabitants manufacture ſilk and cotton ſtuffs, but far inferior to thoſe made at this place in the beginning of the preſent century. The ſilk of this province is exported into the interior part of Perſia, Turkey, Georgia, and Ruſſia. E. Long. 51. 30. N. Lat. 40. 20.

Balaam.

BALAAM, a prophet and diviner of the city of Pethor upon the Euphrates, whoſe practices with Balak king of the Moabites are recorded in the book of Numbers, chap. xxii. It is a queſtion much debated among divines, whether Balaam was a true prophet of God, or no more than a magician or fortune-teller. The Jews indeed are generally of opinion, that he was a buſy and pretending aſtrologer, who, obſerving when men were under a bad aſpect of the ſtars, pronounced a curſe upon them; which ſometimes coming to paſs, gained him in ſome neighbouring nations, a reputation in his way. Several of the ancient fathers ſuppoſe him to be no more than a common ſoothſayer, who undertook to tell future events, and diſcover ſecrets, and by no very juſtifiable arts. Origen will needs have it, that he was no prophet, but only one of the devil's ſorcerers, and that of him he went to inquire; but that God was pleaſed to prevent him and put what anſwers he pleaſed into his mouth. It cannot be denied, however, that the ſcripture expreſsly calls him a prophet (2. Pet. ii. 16.); and therefore ſome later writers have imagined that he had once been a good man and true prophet, till loving the wages of iniquity, and proſtituting the honour of his office to covetouſneſs, he apoſtatiſed from God, and betaking himſelf to idolatrous practices, fell under the deluſion of the devil, of whom he learnt all his magical enchantments, though at this juncture, when the preſervation of his people was concerned, it might be conſiſtent with God's wiſdom to appear to him, and vouchſafe his revelations. As to what paſſed between him and his aſs, when that animal was miraculouſly enabled to ſpeak to its maſter; commentators are divided in their opinions concerning this fact, whether it really and literally happened as Moſes relates it; or whether it be an allegory only, or the mere imagination or viſion of Balaam. This indeed is ſo wonderful an inſtance, that ſeveral of the Jewiſh doctors, who, upon other occaſions are fond enough of miracles, ſeem as if they would hardly be induced to aſſent to this. Philo, in his *Life of Moſes*, paſſes it over in ſilence; and Maimonides pretends that it happened to Balaam in a prophetic viſion only. But St Peter (2 Pet. ii. 16.) ſpeaks of this fact as literal and certain, and ſo all interpreters explain it. St Auſtin, who underſtands it exactly according to the letter, finds nothing in the whole account more ſurpriſing than the ſtupidity of Balaam, who heard his aſs ſpeak to him, and anſwered it as if he talked with a reaſonable perſon. He is of opinion, that this diviner was accuſtomed to prodigies like this, or that he was ſtrangely blinded by his avarice, not to be ſtopped by an event of ſo extraordinary a nature. Le Clerc thinks, that Balaam might probably have imbibed the doctrine of tranſmigration of

Balaam | Balæna.

ſouls, which was certainly very common in the eaſt; and from thence he might be the leſs aſtoniſhed at hearing a brute ſpeak. And Dr Patrick thinks, that Balaam was in ſuch a rage and fury at the ſuppoſed perverſeneſs of his beaſt cruſhing his foot, that for the preſent he could think of nothing elſe; though the conciſeneſs of Moſes's relation, who muſt be preſumed to have omitted many circumſtances, which if rightly known would diſpel this and many more difficulties that may be imagined in this tranſaction, does certainly furniſh us with a better and more ſatisfactory anſwer. St Auſtin is of opinion, that God had not given the aſs a reaſonable ſoul; but permitted it to pronounce certain words, in order to reprove the prophet's covetouſneſs. Gregory of Nyſſa ſeems to think that the aſs did not utter any word articulately or diſtinctly; but that, having brayed as uſual, the diviner, whoſe practice it had been to draw preſages from the cries of beaſts and ſinging of birds, comprehended eaſily the aſs's meaning by its noiſe; Moſes deſigning to ridicule this ſuperſtitious art of augurs and ſoothſayers, as if the aſs really ſpoke in words articulate.

We muſt own, ſays Calmet, that this is a miraculous fact related by an inſpired writer, whoſe authority we are not allowed to call in queſtion in the leaſt particular: but we ſhould ſtudy ſuch ways of explaining it as are moſt conformable to reaſon, and moſt proper to ſolve the difficulties of it, without attacking the truth of the hiſtory. Now it is very poſſible for God to make an aſs ſpeak articulately; it is indeed miraculous, and above the ordinary faculty of this animal, but not againſt the laws of nature.

BALADAN, the ſcripture name for a king of Babylon (Iſa. xxxix. 1. 2 Kings xx. 12.), called by prophane authors *Beleſus* or *Beleſis*, *Nabonaſſar* or *Nanybrus*. Baladan at firſt was no more than governor of Babylon; but entering into a confederacy with Arbaces governor of Media, and rebelling againſt Sardanapalus king of Aſſyria, theſe two generals marched againſt him with an army of 400,000 men, and were beat in three different battles. But the Bactrians deſerting the king, and coming over to Baladan and Arbaces, the rebels attacked the enemy in the night, and made themſelves maſters of his camp. After this misfortune, Sardanapalus retreated to Nineveh, and left the command of his army to his brother-in-law Salamenes. The conſpirators attacked Salamenes, and defeated him in two great battles; after which they laid ſiege to Nineveh. Sardanapalus ſuſtained the ſiege for three years; but the Tigris, in the third year, overflowing its banks, beat down twenty furlongs of the walls; whereupon the conſpirators entered the city and took poſſeſſion of it, after Sardanapalus had burnt himſelf and all his moſt valuable effects upon a funeral pile erected for that purpoſe in his palace. Baladan was acknowledged king of Babylon, as Arbaces was of Media. Berodach-baladan, who ſent embaſſadors to Hezekiah (2 Kings xx.), was the ſon of Baladan.

BALA, a town of Merionethſhire in Wales. W. Long. 3. 37. N. Lat. 52. 54.

BALÆNA, or WHALE, in zoology, a genus of the mammalia claſs, belonging to the order of cete. The characters of this genus are theſe: the balæna, in place of teeth, has a horny plate on the upper jaw, and a double fiſtula or pipe for throwing out water. The ſpecies are four, *viz.*

Balæna.

1 Common whale.

1. The myſticetus, or common whale, which has many turnings and winding in its noſtrils, and has no fin on the back. This is the largeſt of all animals; it is even at preſent ſometimes found in the northern ſeas 90 feet in length; but formerly they there were taken of a much greater ſize, when the captures were leſs frequent, and the fiſh had time to grow. Such is their bulk within the arctic circle; but in thoſe of the torrid zone, where they are unmoleſted, whales are ſtill ſeen 160 feet long. The head is very much diſproportioned to the ſize of the body, being one third the ſize of the fiſh: the under lip is much broader than the upper. The tongue is compoſed of a ſoft ſpongy fat, capable of yielding five or ſix barrels of oil. The gullet is very ſmall for ſo vaſt a fiſh, not exceeding four inches in width. In the middle of the head are two orifices, through which it ſpouts water to a vaſt height, and with a great noiſe, eſpecially when diſturbed or wounded. The eyes are not larger than thoſe of an ox, and when the cryſtalline humour is dried, it does not appear larger than a pea. They are placed towards the back of the head, being the moſt convenient ſituation for enabling them to ſee both before and behind; as alſo to ſee over them, where their food is principally found. They are guarded by eye-lids and eye-laſhes, as in quadrupeds; and they ſeem to be very ſharp-ſighted.

2 Deſcription, &c.

Nor is their ſenſe of hearing in leſs perfection; for they are warned at great diſtances of any danger preparing againſt them. It would ſeem as if nature had deſignedly given them theſe advantages, as they multiply little, in order to continue their kind. It is true, indeed, that the external organ of hearing is not perceptible, for this might only embarraſs them in their natural element; but as ſoon as the thin ſcarf-ſkin after mentioned is removed, a black ſpot is diſcovered behind the eye, and under that is the auditory canal, that leads to a regular apparatus for hearing. In ſhort, the animal hears the ſmalleſt ſounds at very great diſtances, and at all times, except when it is ſpouting water; which is the time that the fiſhers approach to ſtrike it. What is called *whalebone*, adheres to the upper jaw; and is formed of thin parallel laminæ, ſome of the longeſt four yards in length: of theſe there are commonly 350 on each ſide, but in very old fiſh more; about 500 of them are of length fit for uſe, the others being too ſhort. They are ſurrounded with long ſtrong hair, not only that they may not hurt the tongue, but as ſtrainers to prevent the return of their food when they diſcharge the water out of their mouths.—The real bones of the whale are hard, porous, and full of marrow. Two great ſtrong bones ſuſtain the upper lip, lying againſt each other in the ſhape of an half-moon.

The tail is broad and ſemilunar; and when the fiſh lies on one ſide, its blow is tremendous. The tail alone it makes uſe of to advance itſelf forward in the water; and it is ſurpriſing to ſee with what force and celerity its enormous bulk cuts through the ocean. The fins are only made uſe of for turning in the water, and giving a direction to the velocity impreſſed by the tail. The female alſo makes uſe of them, when purſued, to bear off her young, clapping them on her back, and ſupporting

Balæna. ſupporting them by the fins on each ſide from falling. The whale varies in colour; the back of ſome being red, the belly generally white. Others are black, ſome mottled, others quite white; according to the obſervation of Martin, who ſays, that their colours in the water are extremely beautiful, and that their ſkin is very ſmooth and ſlippery. The outward or ſcarf ſkin of the whale is no thicker than parchment; but this removed, the real ſkin appears, of about an inch thick, and covering the fat or blubber that lies beneath: this is from eight to twelve inches in thickneſs; and is, when the fiſh is in health, of a beautiful yellow. The muſcles lie beneath; and theſe, like the fleſh of quadrupeds, are very red and tough. The penis is eight feet in length, incloſed in a ſtrong ſheath. The teats in the female are placed in the lower part of the belly.

3 Mutual fidelity of the male and female. In copulation, the female joins with the male, as is aſſerted, *more humano*; and once in two years feels the acceſſes of deſire. Their fidelity to each other exceeds whatever we are told of, even the conſtancy of birds. Some fiſhers, as Anderſon informs us, having ſtruck one of two whales, a male and a female, that were in company together, the wounded fiſh made a long and terrible reſiſtance: it ſtruck down a boat with three men in it, with a ſingle blow of its tail, by which all went to the bottom. The other ſtill attended its companion, and lent it every aſſiſtance; till at laſt, the fiſh that was ſtruck, ſunk under the number of its wounds; while its faithful aſſociate, diſdaining to ſurvive the loſs, with great bellowing, ſtretched itſelf upon the dead fiſh, and ſhared his fate.—The whale goes with young nine or ten months, and is then fatter than uſual, particularly when near the time of bringing forth. It is ſaid that the embryo, when firſt preceptible, is about 17 inches long, and white; but the cub, when excluded, is black, and about 10 feet long. She generally produces one young one, and never above two. When ſhe ſuckles her young, ſhe throws herſelf on one ſide on the ſurface of the ſea, and the young one attaches itſelf to the teat.

4 Offspring; parental affection, &c. Nothing can exceed the tenderneſs of the female for her offspring; ſhe carries it with her wherever ſhe goes, and, when hardeſt purſued, keeps it ſupported between her fins. Even when wounded, ſhe ſtill claſps her young one; and when ſhe plunges to avoid danger, takes it to the bottom; but riſes ſooner than uſual, to give it breath again. The young ones continue at the breaſt for a year; during which time, they are called by the ſailors, *ſhort-heads*. They are then extremely fat, and yield above 50 barrels of blubber. The mother at the ſame time is equally lean and emaciated. At the age of two years they are called *ſtunts*, as they do not thrive much immediately after quitting the breaſt: they then yield ſcarce above 20 or 24 barrels of blubber; from that time forward they are called *ſkull-fiſh*, and their age is wholly unknown.

5 Are gregarious. Every ſpecies of whale propagates only with thoſe of its own kind, and does not at all mingle with the reſt: however, they are generally ſeen in ſhoals, of different kinds together, and make their migrations in large companies from one ocean to another. They are gregarious animals; which implies their want of mutual defence againſt the invaſions of ſmaller, but more powerful, fiſhes. It ſeems aſtoniſhing, therefore, how a ſhoal of theſe enormous animals find ſubſiſtence together, when it would ſeem that the ſupplying even one with food would require greater plenty than the ocean could furniſh. To increaſe our wonder, we not only ſee them herding together, but uſually find them fatter than any other animals of whatſoever element. We likewiſe know that they cannot ſwallow large fiſhes, as their throat is ſo narrow, that an animal larger than an herring could not enter. How then do they ſubſiſt and grow ſo fat? A certain ſort of ſmall ſnail, or (as Linnæus ſays) the *meduſa* * or ſea-blubber, is ſufficient for this ſupply. Content with this ſimple food, it purſues no other animal, leads an inoffenſive life in its element, and is harmleſs in proportion to its ſtrength to do miſchief. Balæna.

6 Their food. * See *Meduſa*.

7 Inoffenſiveneſs.

As the whale is an inoffenſive animal, it is not to be wondered that it has many enemies, willing to take advantage of its diſpoſition, and inaptitude for combat. There is a ſmall animal, of the ſhell-fiſh kind, called the *whale-louſe*, that ſticks to its body, as we ſee ſhells ſticking to the foul bottom of a ſhip. This inſinuates itſelf chiefly under the fins; and whatever efforts the great animal makes, it ſtill keeps its hold, and lives upon the fat, which it is provided with inſtruments to arrive at.

8 Enemies.

The ſword-fiſh †, however, is the whale's moſt terrible enemy. "At the ſight of this little animal," ſays Anderſon, "the whale ſeems agitated in an extraordinary manner; leaping from the water as if with affright: wherever it appears, the whale perceives it at a diſtance, and flies from it in the oppoſite direction. I have been myſelf," continues he, "a ſpectator of their terrible encounter. The whale has no inſtrument of defence except the tail: with that it endeavours to ſtrike the enemy; and a ſingle blow taking place, would effectually deſtroy its adverſary: but the ſword-fiſh is as active as the other is ſtrong, and eaſily avoids the ſtroke; then bounding into the air, it falls upon its great ſubjacent enemy, and endeavours not to pierce it with its pointed beak, but to cut with its toothed edges. The ſea all about it is ſeen dyed with blood, proceeding from the wounds of the whale; while the enormous animal vainly endeavours to reach its invader, and ſtrikes with its tail againſt the ſurface of the water, making a report at each blow louder than the noiſe of a cannon." In calm weather, the fiſhermen lie upon their oars as ſpectators of this combat, until they perceive the whale at the laſt gaſp: then they row towards him; and his enemy retiring at their approach, they enjoy the fruits of the victory. This account, however, is different in ſeveral reſpects from that commonly given by ſeamen; who report, that a fiſh called the *Threſher* (a ſpecies of SQUALUS), is in league with the *ſword-fiſh*; and that the former keeps on the back of the whale, while the latter wounds it underneath in the belly, which occaſions him to riſe to the ſurface of the water, and to give the threſher an opportunity of aſſiſting in the combat. This he does by throwing himſelf into an erect poſture; and like a *boy* tumbling neck over heels, falls down with aſtoniſhing force on the back of his prey: And thus they go on till the poor whale is deſtroyed. The grampus, and other large fiſhes of the cetaceous order, are attaked and deſtroyed by the ſame enemies in a ſimilar manner.—The whale has another deſperate enemy, a kind of ſhark, of different ſizes from one to three fathoms; ſo voracious, that it

† See *Xiphias*.

6 Conflict with the ſword-fiſh.

Balæna. 10 Anecdotes of the whale-trade.

tears large pieces of flesh from the whale, as if they had been dug with shovels.

To view these animals in a commercial light, we must observe, that the English were late before they engaged in a whale-fishery: it appears by a set of queries, proposed by an honest merchant in the year 1575, in order to get information in the business, that they were at that time totally ignorant of it, being obliged to send to *Biskaie for men skilful in the catching of the whale, and ordering of the oil, and one cooper skilful to set up the staved cask.* This seems very strange; for by the account Octher gives of his travels to King Alfred, near 700 years before that period, it is evident that he made that monarch acquainted with the Norwegians practising the whale-fishery; but it seems all memory of that gainful employ, as well as of that able voyager Octher, and all his important discoveries in the north, were lost for near seven centuries.

Hackluyt's Col. of Voy. 1. 414.

It was carried on by the Biscayeners long before the English attempted the trade; and that for the sake not only of the oil but also of the whalebone, which they seem to have long trafficked in. The earliest notice we find of that article in their trade is by Hackluyt, who says it was brought from the Bay of St Laurence by an English ship that went there for the *barbes* and *fynns* of whales and train oil, A. D. 1594, and who found there 700 or 800 *whale fynnes*, part of the cargo of two great *Biskaine* ships, that had been wrecked there three years before. Previous to that, the ladies stays must have been made of split cane, or some tough wood, as Mr Anderson observes in his Dictionary of Commerce; it being certain that the whale fishery was carried on, for the sake of the oil, long before the discovery of the use of whalebone.

The great resort of these animals was found to be on the inhospitable shores of Spitzbergen, and the European ships made that place their principal fishery, and for numbers of years were very successful: the English commenced that business about the year 1598, and the town of Hull had the honour of first attempting that profitable branch of trade. At present it seems to be on the decline, the quantity of fish being greatly reduced by the constant capture for such a vast length of time: some recent accounts inform us, that the fishers, from a defect of whales, apply themselves to seal fishery, from which animals they extract an oil. This we fear will not be of very long continuance; for these shy and timid creatures will soon be induced to quit those shores by being perpetually harrassed, as the morse or walrus has already in a great measure done. We are also told, that the poor natives of Greenland begin even now to suffer from the decrease of the seal in their seas, it being their principal subsistence; so that, should it totally desert the coast, the whole nation would be in danger of perishing through want.

Pennant's Brit. Zool. 8vo, III. 53. &c.

In old times the whale seems never to have been taken on the British coasts, but when it was accidentally flung ashore: it was then deemed a royal fish, and the king and queen divided the spoil; the king asserting his right to the head, her majesty to the tail.—For the manner of taking whales, see *Whale* FISHERY.

11 Other species.

2. The physalus, or fin-fish, is distinguished from the common whale by a fin on the back, placed very low and near the tail. The length is equal to that of the common kind, but much more slender. It is furnished with whale-bone in the upper jaw, mixed with hairs, but short and knotty, and of little value. The blubber also on the body of this kind is very inconsiderable. These circumstances, added to its extreme fierceness and agility, which renders the capture very dangerous, cause the fishers to neglect it. The natives of Greenland, however, hold it in great esteem, as it affords a quantity of flesh which to their palate is very agreeable. The lips are brown, and like a twisted rope: the spout-hole is as it were split in the top of its head, through which it blows water with much more violence, and to a greater height, than the common whale. The fishers are not very fond of seeing it, for on its appearance the others retire out of those seas. Some writers conjecture this species to have been the Φυσαλος, and *physeter*, or blowing-whale of Oppian, Ælian, and Pliny: but since those writers have not left the least description of it, it is impossible to judge which kind they meant; for in respect to the faculty of spouting out water, or blowing, it is not peculiar to any one species, but common to all the whale kind. The physalus inhabits the European and American oceans: it feeds upon herrings and other small fish.

Balæna, Balagate.

3. The boops, or pike-headed whale, has a double pipe in its snout, three fins like the former, and a hard horny ridge on its back. The belly is full of longitudinal folds or rugæ. It frequents the northern ocean. The length of that taken on the coast of Scotland, as remarked by Sir Robert Sibbald, was 46 feet, and its greatest circumference 20. This species takes its name from the shape of its nose, which is narrower and sharper-pointed than that of other whales.

4. The musculus has a double pipe in its front, and three fins; the under jaw is much wider than the upper one. It frequents the Scotch coasts, and feeds upon herrings.

Linnæus makes the physeter and delphinus, which are ranked among the whales by some writers, two distinct genera. See PHYSETER and DELPHINUS.

BALAGATE, a province of the Mogul empire, and the largest of the three that compose the kingdom of Dekkan. It has Kandish and Barar to the north, Tellinga to the east, Baglana with part of Guzerat to the west, and Visiapur to the south. It is a fruitful and pleasant country, abounding with cotton and sugar. Here they have sheep without horns; but so strong, that when bridled and saddled they will carry boys of ten years of age. Its present capital is Aurengabad, but formerly was Dowlet Abad; and from the latter the whole province is sometimes called *Dowlet-Abad.*

BALAGATE Mountains, a chain of mountains which divides the coast of Malabar from that of Coromandel, running almost the whole length of the peninsula on this side the Ganges. Some parts of them are covered with fine red earth, which is blown by the strong west winds as far as the island of Ceylon; and when the rays of the sun are reflected from these mountains, they seem to be all on fire. They make surprising alterations in the seasons; for on the north side of cape Comorin, it is winter in May, June, July, August, and September, in which months it is summer on the south side of the cape; on one side there are continual tempests, thunder and lightning, while the other enjoys a constant serenity. When black clouds are gathered about

BRITISH MUSEUM

Fig. 2. Atropa Mandragora.

Fig. 3.

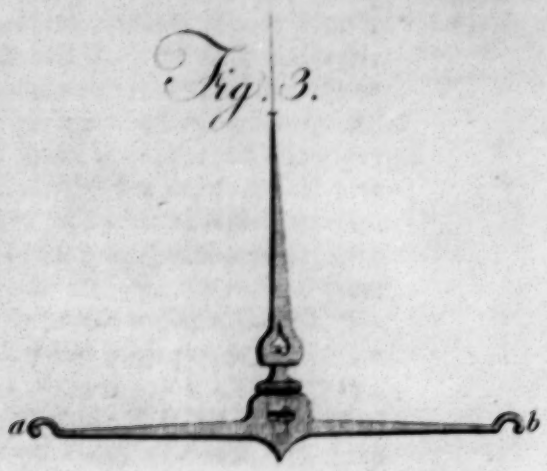

Fig. 4. Common Balance.

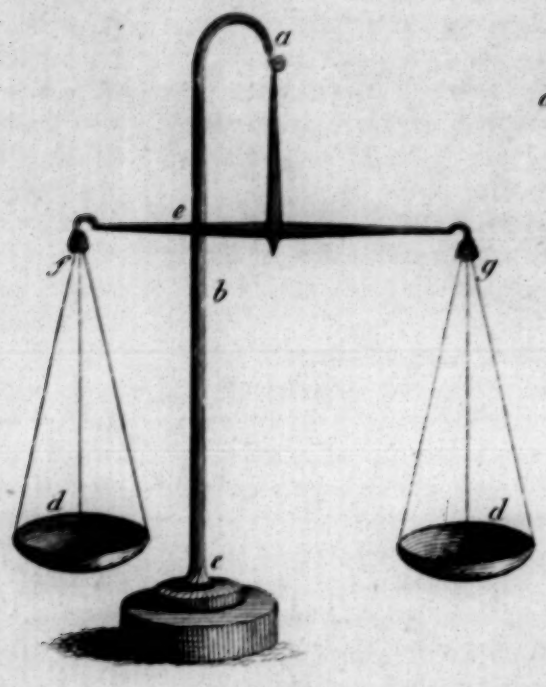

Fig. 5. Hydrostatic Balance.

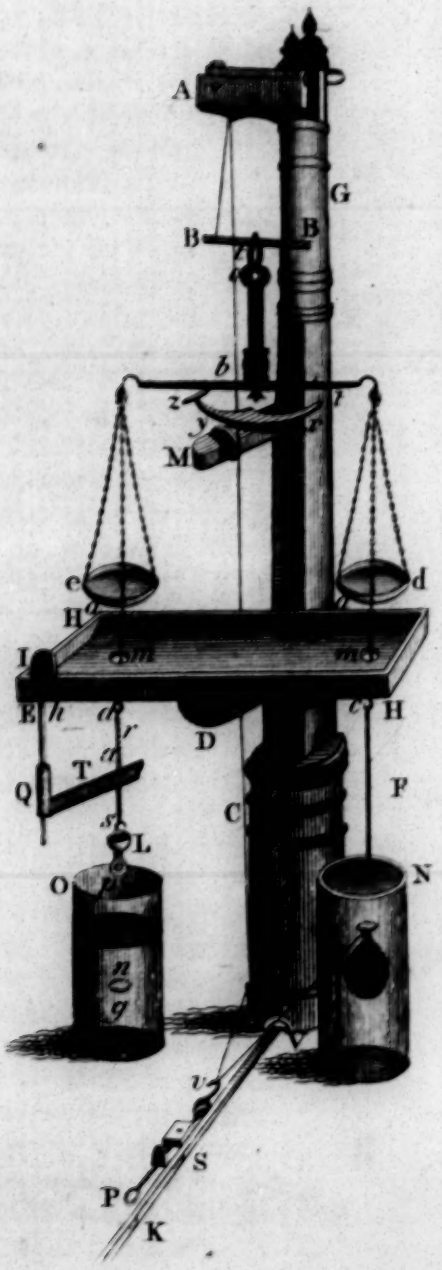

Fig. 6. Roman Balance.

Fig. 7. Assay Balance.

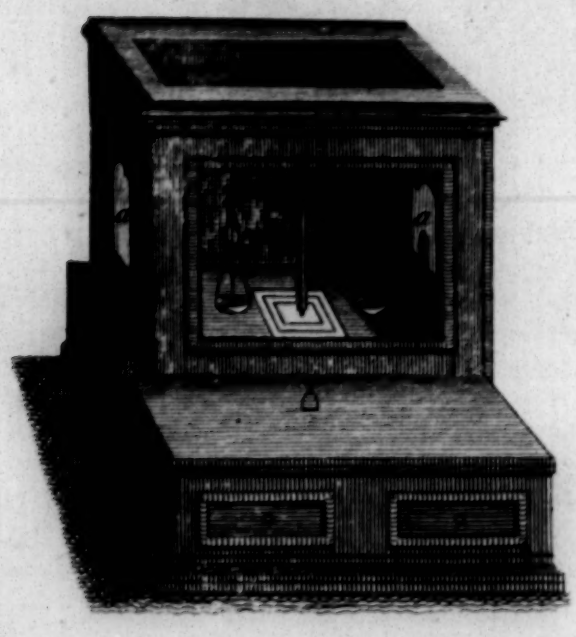

Fig. 1.

Thackara & Vallance, sculp!

Balagnia. Balance.

about the mountains, they are followed by ſudden rain, which cauſes the overflowing of the rivers, and choaks them up with ſand, inſomuch that they are unnavigable for ſome time afterwards. The buildings and clothes of the inhabitants are ſcarce ſufficient to defend them from the weather. They live upon rice, milk, roots, and herbs, with very little meat: they have likewiſe a ſort of ſmall arrac, but are never given to drunkenneſs; nor do they import foreign vices, for they never travel abroad.

BALAGNIA, a town of Muſcovy, in the province of little Novogorod, ſeated on the Wolga. E. Long. 45. 5. N. Lat. 50. 36.

BALAGUER, a city of Catalonia in Spain, ſeated on the north bank of the river Segra, at the foot of a high mountain, on which there was formerly a fortreſs. E. Long. 0. 48. N. Lat 41. 38.

BALAMBUAN, or PADAMBUAN, a ſtrong town of Aſia in the Indies on the eaſt end of the iſland of Java, and capital of a territory of the ſame name. E. Long. 115. 30. S. Lat. 7. 50.

BALANCE, or BALLANCE, one of the ſix ſimple powers in mechanics, principally uſed in determining the equality or difference of weights in heavy bodies, and conſequently their maſſes or quantity of matter.

The balance is of two kinds: the ancient and the modern. The ancient or Roman called alſo the *ſtatera Romana*, or ſteel-yard, conſiſts of a lever or beam, moveable on a centre, and ſuſpended near one of its extremities; the bodies to be weighed or applied on one ſide of the centre; and their weight is ſhown by the diviſion marked on the beam, where the weight, which is moveable along the lever, keeps the ſteel-yard *in equilibrio*. This balance is ſtill frequently uſed in weighing heavy bodies.

The modern balance now generally uſed conſiſts of a lever or beam ſuſpended exactly in the middle, having ſcales or baſons hung to each extremity. The lever is called the *jugum* or *beam*; and the two moieties thereof on each ſide the axis, the *brachia* or *arms*. The line on which the beam turns, or which divides its brachia, is called the *axis*; and when conſidered with regard to the length of the brachia, is eſteemed a point only, and called the *centre of the balance*; the handle whereby it is held, or by which the whole apparatus is ſuſpended, is called *trutina*; and the ſlender part perpendicular to the beam, whereby either the equilibrium or preponderancy of bodies is indicated, is called the *tongue* of the balance. Thus in fig. 3. *a b* is the beam, divided into two equal brachia or arms by the white ſpot in the centre, which is the axis or centre of the balance, and *c* is the tongue. The trutina, on which the axis is ſuſpended, is not repreſented in this figure, in order to render the other parts more conſpicuous.

Plate XCI.

It follows, from what has been obſerved, therefore, that in the Roman balance, the weight uſed for a counterpoiſe is the ſame, but the point of application varies; in the common balance the counterpoiſe is various, and the point of application the ſame. The principle on which each is founded, may be very eaſily underſtood from the following obſervations, and the general properties of the lever. See LEVER.

The beam A B (fig. 6), is a lever of the firſt kind; but inſtead of reſting on a fulcrum, is ſuſpended by ſomething faſtened to its centre of motion: conſequently the mechaniſm of the balance depends on the ſame theorems as the lever. Balance.

Hence as the quantity of matter in known weight is to its diſtance from the centre of motion, ſo its diſtance of the unknown weight to its quantity of matter. Hence the nature and uſe of the ſteel-yard is eaſily known. Let AB (fig. 6.) repreſent an inſtrument of this kind; *a*, the trutina or handle on which the beam turns; *k*, a ring on which the balance may be ſupended on a nail or hook; *f*, the hook on which the body to be weighed is hung; *c*, a collar or guard by which the hook *f* is faſtened to the beam; *g*, a moveable collar; *h*, a ſwivel; *i*, the counterpoiſe. From what has been ſaid it evidently follows, that if the body to be weighed be faſtened to the hook *f*, and the whole ſupended to the ring *k*, the diviſion on which the counterpoiſe is placed to maintain an equilibrium in the balance, will ſhow the weight of the body required; provided the weight of the counterpoiſe *i* be known, and the large diviſions, 1, 2, 3, &c. be equal to the diſtance between the centre of the balance and the ſcrew which faſtens the guard *c* to the ſhorter arm of the balance. It will alſo be neceſſary that the ſteel-yard itſelf, with its whole apparatus, excluſive of the counterpoiſe, be *in equilibrio*, when ſuſpended on the ring *k*. If the body to be weighed be heavier than the diviſions on the longer arm will indicate, the balance is turned the lower ſide upwards, and ſuſpended on the other ring *b*; by which means the diviſions become ſhorter, becauſe the diſtance between the trutina *d*, and the ſcrew on which the guard *c* moves, is leſs: the diviſions in the figure on this ſide extending to 17, whereas they extend only to 6 on the other. It will be unneceſſary perhaps to obſerve, that the ſame precaution, with regard to the centre of gravity when the balance is ſuſpended, is alſo neceſſary when this ſide of the balance is uſed, as we before mentioned with regard to the other.

We have already obſerved, that in the common ſcales the two brachia or arms of the balance, *e f*, *e g*, fig. 4. are equal to each other, and conſequently equal weights placed in the ſcales *d d*, will be *in equilibrio* when the balance is ſuſpended on its centre *e*, as in the figure, where the ring at the extremity of the trutina is hung on the tapering rod *a b*, fixed in the foot or baſis *c*.

The Deceitful BALANCE, or that which cheats by the inequality of its brachia, is founded on the ſame principle as the ſteel-yard. Let there be, for example, a balance ſo conſtructed, that both the brachia with their ſcales ſhould equiponderate, but that the length of the one arm ſhould be to that of the other as 10 to 9. In this caſe, a weight of nine pounds put into the longeſt arm, will counterpoiſe one of ten pounds put into the ſhorter one: but the cheat is immediately diſcovered by ſhifting the weight from one ſcale to the other; in which caſe, the balance will no longer remain in *equilibrio*.

*Aſſay-*BALANCE, a very nice balance uſed in docimaſtical operations, to determine exactly the weight of minute bodies; ſee fig. 7. This balance ſhould be made of the beſt ſteel, and of the hardeſt kind; becauſe that

Balance. that metal is not ſo eaſily ſpoiled with ruſt as iron; and it is more apt than any other to take a perfect poliſh, which at the ſame time prevents the ruſt.

The ſtructure of the aſſayer's ſcale is little different from that of common ſcales, otherwiſe than by its nicety and ſmallneſs. The longer the beam of it is, the more exact may the weight of a body be found; however, 10 or 12 inches are a ſufficient length. Let the thickneſs of it be ſo little, that two drams may hardly be hung at either of its extremities without its bending; for the largeſt weight put upon it ſeldom exceeds one dram. The whole ſurface of this beam muſt be altogether without ornaments, which only increaſe the weight and gather duſt, &c. The beam is ſuſpended in a fork, the two legs of which are ſteel ſprings joined at top, but kept together below with a braſs pliant claſp, parallel, and two lines and a half diſtant from each other. This claſp being taken off, and the legs of the fork being ſtretched out, the axis of the beam may be put into two holes made for that purpoſe at the ends of the legs, or be taken away from them. Let a very ſharp needle be fixed in the head of the fork, ſtanding perpendicularly downwards, if the fork is ſuſpended, and ſo long, as that it may almoſt touch the top of the tongue of the beam put into the fork when in equilibrio. This needle is the mark of the equilibrium; and that the artiſts may be able to obſerve this, the legs of the fork muſt be broader in that place, and have an opening two or three lines wide; this fork may be adorned at pleaſure, provided the motion of the balance is not hindered by ſuch ornaments; then take two ſcales made of thin plate of ſilver, one inch and a half in diameter, hanging on three ſmall ſilk ſtrings, almoſt as long as the beam tied together at top, with a ſilver hook in form of an S, and hang them to the extremities of the beam: a ſmaller ſilver diſh or blued ſteel, ſomewhat leſs than one inch in diameter, belongs to each of theſe ſcales. You firſt put into theſe diſhes, with a pair of pincers, the bodies to be weighed, or with a ſpoon or ſmall ſhovel, when they are pounded, and then you put them into the ſcales; therefore the ſmall diſhes muſt be perfectly equal in weight. We uſe them, that bodies may be more conveniently put into and taken out of the ſcales, and that theſe which are vaſtly thin may not be bent or ſoiled, and thence rendered falſe by wiping.

This balance is ſuſpended on a moveable braſs or copper ſupport, which conſiſts of a pedeſtal, and of a column ſet upon it about 20 inches high, at the top of which comes out at right angles an arm one inch long. At the extremity of this arm, put a ſmall pulley three lines in diameter, another at the top of the column, and a third near the bottom of it; all which pullies muſt turn very eaſily on their axes. At the diſtance of one inch and a half below the upper arm, let another arm one inch and a half long come out of the column at right angles, having a hole through it two lines long, a quarter of a line broad, and placed perpendicularly below the pulley of the upper arm, to receive a ſmall plate, one inch and a half long; and of ſuch breadth and thickneſs as that it may freely move up and down, and yet not have too much play within the hole. This plate muſt alſo have a ſmall hook at each extremity.

And as ſuch a balance will hardly ſtand ſtill in the open air, and becomes falſe when ſpoiled with duſt; Balance. it muſt be put, together with its ſupports, into a ſmall caſe as repreſented in fig. 7. having glaſſes, *a*, *a*, *a*, at top, and all round it, that you may ſee what is within.

*Manner of uſing the aſſay-*BALANCE.—Paſs a ſilk ſtring over the three pullies of the ſupport, and tie it at its upper extremity to the ſmall hook introduced into the hole of the inferior arm; then put the ſupport in the middle of the ſmall caſe, and paſs the other extremity of the ſilk ſtring below, through a hole bored in the middle of the lower part of the frame, containing the window in the fore part of the caſe, and faſten it to a ſmall weight of a cubic form. Suſpend the fork of the balance on the inferior hook of the plate. By this means if you move backwards and forwards the weight faſtened to the ſtring, placed upon the top of the drawer jutting out beyond the fore-part of the caſe, the balance within is either lifted up or let down. But you muſt put the bodies to be weighed, and the weights themſelves, in the ſmall ſilver diſhes; and theſe, when loaded, into the ſcales, thro' the ſide-windows, which muſt be opened for that purpoſe. When any thing is to be added to or taken out of them, you do it with the ſmall pincers; or, if it is powder, with the ſmall ſhovel or ſpoon: but you muſt let the balance down every time any thing is to be added or taken away, that the ſcales may reſt upon the bottom of the caſe; and ſhut the windows before the balance is lifted up again, eſpecially if the air is not perfectly calm.

Hydroſtatic BALANCE, an inſtrument contrived to determine accurately the ſpecific gravity of both ſolid and fluid bodies. It is conſtructed in various forms; but we ſhall content ourſelves here with deſcribing that which appears of all others the moſt accurate.

VCG, (fig. 5) is the ſtand or pillar of this hydroſtatic balance, which is to be fixed in a table. From the top A, hangs, by two ſilk ſtrings, the horizontal bar B B, from which it is ſuſpended by a ring *i*, the fine beam of a balance *b*; which is prevented from deſcending too low on either ſide by the gently ſpringing piece *t x y z*, fixed on the ſupport M. The harneſs is annulated at *o*, to ſhow diſtinctly the perpendicular poſition of the examen, by the ſmall pointed index fixed above it.

The ſtrings by which the balance is ſuſpended, paſſing over two pullies, one on each ſide the piece at A, go down to the bottom on the other ſide, and are hung over the hook at *v*; which hook, by means of a ſcrew P, is moveable about one inch and a quarter, backward and forward, and therefore the balance may be raiſed or depreſſed ſo much. But if a greater elevation or depreſſion be required, the ſliding piece S, which carries the ſcrew P, is readily moved to any part of the ſquare braſs rod V K, and fixed by means of a ſcrew.

The motion of the balance being thus adjuſted, the reſt of the apparatus is as follows. H H is a ſmall board, fixed upon the piece D, under the ſcales d and e, and is moveable up and down in a low ſlit in the pillar above C, and faſtened at any part by a ſcrew behind. From the point in the middle of the bottom of each ſcale, hangs, by a fine hook, a braſs wire *a d* and *a c*. Theſe paſs through two holes *m m* in the table

Balance. table. To the wire *a d* is ſuſpended a curious cylindric wire, *r s*, perforated at each end for that purpoſe: this wire *r s* is covered with paper, graduated by equal diviſions, and is about five inches long.

In the corner of the board at E, is fixed a braſs tube, on which a round wire *h l* is ſo adapted as to move neither too tight nor too free, by its flat head I. Upon the lower part of this moves another tube Q, which has ſufficient friction to make it remain in any poſition required: to this is fixed an index T, moving horizontally when the wire *h l* is turned about, and therefore may be eaſily ſet to the graduated wire *r s*. To the lower end of the wire *r s* hangs a weight L; and to that a wire *p n*, with a ſmall braſs ball *g* about one-fourth of an inch diameter. On the other ſide, to the wire *a c*, hangs a large glaſs bubble R, by a horſe-hair.

Let us firſt ſuppoſe the weight L taken away, and the wire *p n* ſuſpended from S: and, on the other ſide, let the bubble R be taken away, and the weight F ſuſpended at *c*, in its room. This weight F we ſuppoſe to be ſufficient to keep the ſeveral parts hanging to the other ſcale in equilibrium; at the ſame time that the middle point of the wire *p n* is at the ſurface of the water in the veſſel N. The wire *p n* is to be of ſuch a ſize, that the length of one inch ſhall weigh four grains.

Now it is evident, ſince braſs is eight times heavier than water, that for every inch the wire ſinks in the water it will become half a grain lighter, and half a grain heavier for every inch it riſes out of the water: conſequently, by ſinking two inches below the middle point, or riſing two inches above it, the wire will become one grain lighter or heavier. Therefore, if, when the middle point is at the ſurface of the water in equilibrium, the index T be ſet to the middle point *a* of the graduated wire *r s*, and the diſtance on each ſide *a r* and *a s* contains 100 equal parts; then if, in weighing bodies the weight is required to the hundredth part of a grain, it may be eaſily had by proceeding in the following manner.

Let the body to be weighed be placed in the ſcale d. Put the weight X in the ſcale e; and let this be ſo determined, that one grain more ſhall be too much, and one grain leſs too little. Then the balance being moved gently up or down, by the ſcrew P, till the equilibrium be nicely ſhown at *o*; if the index T be at the middle point *a* of the wire *r s*, it ſhows that the weights put into the ſcale e are juſt equal to the weight of the body. By this method we find the abſolute weight of the body: the relative weight is found by weighing it hydroſtatically in water, as follows.

Inſtead of putting the body into the ſcale e, as before, let it hang with the weight F, at the hook *c*, by a horſe-hair, as at R, ſuppoſing the veſſel O of water were away. The equilibrium being then made, the index T ſtanding between *a* and *r*, at the 36 diviſion, ſhows the weight of the body put in to be 1095,36 grains. As it thus hangs, let it be immerſed in the water of the veſſel O, and it will become much lighter: the ſcale e will deſcend till the beam of the balance reſt on the ſupport *z*. Then ſuppoſe 100 grains put into the ſcale d reſtore the equilibrium preciſely, ſo that the index T ſtand at the 36 diviſion above *a*; it is evident that the weight of an equal bulk of water would, in this caſe be exactly 100 grains. Balance ‖ Balbec.

After a like manner this balance may be applied to find the ſpecific gravity of liquids as is eaſy to conceive from what has been ſaid.

Balance of Trade. That which is commonly meant by the balance of trade, is the equal importing of foreign commodities with the exporting of the native. And it is reckoned that nation has the advantage in the balance of trade, which exports more of the native commodities, and imports leſs of the foreign. The reaſon of this is, that, if the native commodities be of a greater value than are imported, the balance of that account muſt be made up in bullion or money: and the nation grows ſo much richer, as the balance of that account amounts to.

Balance of a Clock, or *Watch*, is that part which regulates the beats. See *Clock-Making*.

Balance-Fiſh. See Squalus.

BALANCER, in the hiſtory of inſects, a ſtyle, or oblong body, ending in a protuberance or head, found under each wing of the two-winged flies; theſe ſerve to poiſe the body of the fly.

BALANCING, among ſeamen, the contracting a ſail into a narrower compaſs, in a ſtorm, by retrenching, or folding up a part of it at one corner: this method is uſed in contradiſtinction to reefing, which is common to all the principal ſails; whereas balancing is peculiar to few, ſuch as the mizen of a ſhip, and the main-ſail of thoſe veſſels wherein it is extended by a boom. See Boom and Reef.—The balance of the mizen is thus performed: the mizen yard is lowered a little, then a ſmall portion of the ſail is rolled up at the peek or upper corner, and faſtened to the yard about one-fifth inward from the outer end or yard-arm toward the maſt. See Mizen.—A boom main-ſail is balanced, after all its reefs are taken in, by rolling up a ſimilar portion of the hindmoſt or aftmoſt lower corner called the *clue*, and faſtening it ſtrongly to the boom, having previouſly wrapped a piece of old canvas round the part (which is done in both caſes) to prevent the ſail from being fretted by the cord which faſtens it.

BALANUS, in zoology, the trivial name of a ſpecies of lepas. See Lepas.

BALANSTINES, in botany. See Punica.

BALAYAN, a province of the iſland of Manila in the Eaſt Indies, belonging to the Spaniards.—It lies next to the city of Manila, and extends along the coaſt on the eaſt ſide of the iſland, a little beyond the bay of Batangas. There were formerly gold mines in it, but they have been long ſince abandoned. It is inhabited by about 2500 tributary Indians, and abounds in cotton, rice, and palm-trees. The province is well cultivated; and the Spaniards, generally ſpeaking, have country-houſes in it.

BALBASTRO, a principal town of Spain, in the kingdom of Arragon, and capital of a diſtrict of the ſame name. E. Long. 0. 20. N. Lat. 41. 50.

BALBEC, a city of Aſia in Syria, anciently called *Heliopolis*, and by the Arabians the *wonder of Syria*. It is ſituated at the foot of Anti-Lebanon, preciſely on the laſt riſing ground where the mountain terminates in the plain. As we arrive from the ſouth we dif-

Balbec. discover the city only at the distance of a league and a half, behind a hedge of trees over the verdant tops of which appears a white edging of domes and minarets. After an hour's journey we reach these trees, which are very fine walnuts; and soon after, crossing some ill-cultivated gardens, by winding paths, arrive at the entrance of the city. We there perceive a ruined wall flanked with square towers, which ascends the declivity to the right, and traces the precincts of the ancient city. This wall, which is only ten or twelve feet high, permits us to have a view of those void spaces and heaps of ruins which are the invariable appendage of every Turkish city; but what principally attracts our attention is a large edifice on the left, which, by its lofty walls and rich columns, manifestly appears to be one of those temples which antiquity has left for our admiration. These ruins, which are some of the most beautiful and best preserved of any in Asia, merit a particular description.

To give a just idea of them, we must suppose ourselves descending from the interior of the town. After having crossed the rubbish and huts with which it is filled, we arrive at a vacant place which appears to have been a square; there, in front, towards the west, we perceive a grand ruin, which consists of two pavilions ornamented with pilasters, joined at their bottom angle by a wall 160 feet in length. This front commands the open country from a sort of terrace, on the edge of which we distinguish with difficulty the bases of twelve columns, which formerly extended from one pavilion to the other and formed a portico. The principal gate is obstructed by heaps of stones; but, that obstacle surmounted, we enter an empty space, which is an hexagonal court of 180 feet diameter. This court is strewed with broken columns, mutilated capitals, and the remains of pilasters, entablatures, and cornices; around it is a row of ruined edifices which display all the ornaments of the richest architecture. At the end of this court, opposite the west is an outlet, which formerly was a gate through which we perceive a still more extensive range of ruins, whose magnificence strongly excites curiosity. To have a full prospect of these, we must ascend a slope, up which were the steps to this gate; and we then arrive at the entrance of a square court, much more spacious than the former, being 350 wide and 336 in length. The eye is at first attracted by the end of this court, where six enormous and majestic columns render the scene astonishingly grand and picturesque. Another object not less interesting is a second range of columns to the left, which appear to have been part of the peristyle of a temple; but before we pass thither, we cannot refuse particular attention to the edifices which inclose this court on each side. They form a sort of gallery which contains various chambers, seven of which may be reckoned in each of the principal wings, viz. two in a semicircle and five in an oblong square. The bottom of these apartments still retains pediments of niches and tabernacles, the supporters of which are destroyed. On the side of the court they are open, and present only four and six columns totally destroyed. It is not easy to conceive the use of these apartments; but this does not diminish our admiration at the beauty of their pilasters and the richness of the frize of the entablature. Neither is it possible to avoid Balbec. remarking the singular effect which results from the mixture of the garlands, the large foliage of the capitals, and the sculpture of wild plants with which they are every where ornamented. In traversing the length of the court, we find in the middle a little square esplanade, where was a pavilion, of which nothing remains but the foundation. At length we arrive at the foot of the six columns; and then first conceive all the boldness of their elevation and the richness of their workmanship. Their shafts are 21 feet eight inches in circumference and 58 high; so that the total height, including the entablature, is from 71 to 72 feet. The sight of this superb ruin, thus solitary and unaccompanied, at first strikes us with astonishment; but, on a more attentive examination, we discover a series of foundations which mark an oblong square of 268 feet in length and 146 wide, and which, it seems probable, was the peristyle of a grand temple, the primary purpose of this whole structure. It presented to the great court, that is to the east, a front of ten columns, with 19 on each side, which with the other six make in all 54. The ground on which it stood was an oblong square, on a level with this court, but narrower than it, so that there was only a terrace of 27 feet wide round the colonnade; the esplanade this produces fronts the open country toward the west, by a sloping wall of about 30 feet. This descent as you approach the city becomes less steep, so that the foundation of the pavilion is on a level with the termination of the hill; whence it is evident that the whole ground of the courts has been artificially raised. Such was the former state of this edifice; but the southern side of the grand temple was afterwards blocked up to build a smaller one, the peristyle and walls of which are still remaining. This temple, situated somewhat lower than the other, presents a side of 13 columns by eight in front (in all 34), which are likewise of the Corinthian order; their shafts are 15 feet eight inches in circumference, and 44 in height. The building they surround is an oblong square, the front of which, turned towards the east, is out of the line of the left wing of the great court. To reach it you must cross trunks of columns, heaps of stone, and a ruinous wall by which it is now hid. After surmounting these obstacles you arrive at the gate, where you may survey the inclosure which was once the habitation of a god; but instead of the awful scene of a prostrate people and sacrifices offered by a multitude of priests, the sky, which is open from the falling in of the roof, only lets in light to show a chaos of ruins covered with dust and weeds. The walls, formerly enriched with all the ornaments of the Corinthian order, now present nothing but pediments of niches and tabernacles, of which almost all the supporters are fallen to the ground. Between these niches is a range of fluted pilasters, whose capitals support a broken entablature; but what remains of it displays a rich frize of foliage resting on the heads of satyrs, horses, bulls, &c. Over this entablature was the ancient roof, which was 57 feet wide and 110 in length. The walls which supported it are 31 feet high, and without a window. It is impossible to form any idea of the ornaments of this roof, except from the fragments lying on the ground; but it could not have been

richer

Balbec. richer than the gallery of the periſtyle: the principal remaining parts contain tablets in the form of lozenges, on which are repreſented Jupiter ſeated on his eagle; Leda careſſed by the ſwan; Diana with her bow and creſcent; and ſeveral buſts which ſeem to be figures of emperors and empreſſes. It would lead us too far to enter more minutely into the deſcription of this aſtoniſhing edifice. The lovers of the arts will find it deſcribed with the greateſt truth and accuracy in a work publiſhed at London in 1757 under the title of *Ruins of Balbec*. This work, compiled by Mr Robert Wood, the world owes to the attention and liberality of Mr Dawkins, who in 1751 viſited Balbec and Palmyra. But ſeveral changes, however, have taken place ſince their journey: for example, they found nine large columns ſtanding, and in 1784 Mr Volney found but ſix. They reckoned 29 at the leſſer temple, but there now remain but 20; the others have been overthrown by the earthquake of 1759. It has likewiſe ſo ſhaken the walls of the leſſer temple, that the ſtone of the ſoffit, or croſs ſtone at the top, of the gate was ſlid between the two adjoining ones, and deſcended eight inches; by which means the body of the bird ſculptured on that ſtone is ſuſpended detached from its wings and the two garlands which hung from its beak and terminated in two genii. Nature alone has not effected this devaſtation; the Turks have had their ſhare in the deſtruction of the columns. Their motive is to procure the iron cramps, which ſerve to join the ſeveral blocks of which each column is compoſed. Theſe cramps anſwer ſo well the end intended, that ſeveral of the columns are not even disjointed by their fall; one, among others, as Mr Wood obſerves, has penetrated a ſtone of the temple wall without giving way; nothing can ſurpaſs the workmanſhip of theſe columns; they are joined without any cement, yet there is not room for the blade of a knife between their interſtices. After ſo many ages, they in general ſtill retain their original whiteneſs. But what is ſtill more aſtoniſhing, is the enormous ſtones which compoſe the ſloping wall. To the weſt the ſecond layer is formed of ſtones which are from 28 to 35 feet long, by about nine in height. Over this layer, at the north-weſt angle, there are three ſtones which alone occupy a ſpace of 175½ feet; viz. the firſt 58 feet ſeven inches: the ſecond 58 feet 11, and the third exactly 58 feet; and each of theſe are 12 feet thick. Theſe ſtones are of a white granite, with large ſhining flakes like gypſe; there is a quarry of this kind of ſtone under the whole city and in the adjacent mountain, which is open in ſeveral places, and among others on the right, as we approach the city. There is ſtill lying there a ſtone, hewn on three ſides, which is 69 feet two inches long, 12 feet 10 inches broad, and 13 feet three in thickneſs. By what means could the ancients move theſe enormous maſſes? This is doubtleſs a problem in mechanics curious to reſolve. The inhabitants of Balbec have a very commodious manner of explaining it, by ſuppoſing theſe edifices to have been conſtructed by *Djenoun*, or genii, who obeyed the orders of King Solomon; adding, that the motive of ſuch immenſe works was to conceal in ſubterraneous caverns vaſt treaſures, which ſtill remain there. To diſcover theſe, many have deſcended into the vaults which range under the whole edifice; but the inutility of their reſearches, added to the oppreſſions and extortions of the governors, who have made their ſuppoſed diſcoveries a pretext, have at length diſheartened them; but they imagine the Europeans would be more ſucceſsful, nor would it be poſſible to perſuade them but what we are poſſeſſed of the magic art of deſtroying taliſmans. It is in vain to oppoſe reaſon to ignorance and prejudice: and it would be no leſs ridiculous to attempt to prove to them that Solomon never was acquainted with the Corinthian order, which was only in uſe under the Roman emperors. But their tradition on the ſubject of this prince may ſuggeſt three important obſervations. Firſt, That all tradition relative to high antiquity is as falſe among the Orientals as the Europeans. With them, as with us, facts which happened 100 years before, when not preſerved in writing, are altered, mutilated, or forgotten. To expect information from them with reſpect to events in the time of David or Alexander, would be as abſurd as to make inquiries of the Flemiſh peaſants concerning Clovis or Charlemagne. Secondly, That throughout Syria, the Mahometans, as well as the Jews and Chriſtians, attribute every great work to Solomon: not that the memory of him ſtill remains by tradition in thoſe countries, but from certain paſſages in the Old Teſtament; which, with the goſpel, is the ſource of almoſt all their tradition, as theſe are the only hiſtorical books read or known; but as their expounders are very ignorant, their applications of what they are told are generally very remote from truth: by an error of this kind they pretend Balbec is *the houſe of the foreſt of Lebanon* built by Solomon; nor do they approach nearer probability when they attribute to that king the well of Tyre and the buildings of Palmyra. Thirdly, That the belief in hidden treaſures has been confirmed by diſcoveries which have been really made from time to time. It is not many years ſince a ſmall coffer was found at Hebron full of gold and ſilver medals, with an ancient Arabic book on medicine. In the country of the Druzes an individual diſcovered likewiſe, ſome time ſince, a jar with gold coin in the form of a creſcent; but as the chiefs and governors claim a right to theſe diſcoveries, and ruin thoſe who have made them, under pretext of obliging them to make reſtoration, thoſe who find any thing endeavour carefully to conceal it; they ſecretly melt the antique coins, nay, frequently bury them again in the ſame place where they found them, from the ſame fears which cauſed their firſt concealment, and which prove the ſame tyranny formerly exiſted in theſe countries. Balbec.

When we conſider the extraordinary magnificence of the temple of Balbec, we cannot but be aſtoniſhed at the ſilence of the Greek and Roman authors. Mr Wood, who has carefully examined all the ancient writers, has found no mention of it except in a fragment of John of Antioch, who attributes the conſtruction of this edifice to Antoninus Pius. The inſcriptions which remain corroborate this opinion, which perfectly accounts for the conſtant uſe of the Corinthian order, ſince that order was not in general uſe before the third age of Rome; but we ought by no means to allege as an additional proof the bird ſculptured over the gate; for if his crooked beak, large claws, and

Balbec Balbus.

the caduceus he bears, give him the appearance of an eagle, the tuft of feathers on his head, like that of certain pigeons, proves that he is not the Roman eagle: beſides that the ſame bird is found in the temple of Palmyra; and is therefore evidently an Oriental eagle, conſecrated to the ſun, who was the divinity adored in both theſe temples. His worſhip exiſted at Balbec in the moſt remote antiquity. His ſtatue, which reſembled that of Oſiris, had been tranſported there from the Heliopolis of Egypt, and the ceremonies with which he was worſhipped there have been deſcribed by Macrobius, in his curious work entitled *Saturnalia*. Mr Wood ſuppoſes with reaſon, that the name of Balbec, which in Syriac ſignifies *City of Bal*, or of the ſun, originated in this worſhip. The Greeks, by naming it *Heliopolis*, have in this inſtance only given a literal tranſlation of the oriental word; a practice to which they have not always adhered. We are ignorant of the ſtate of this city in remote antiquity; but it is to be preſumed, that its ſituation, on the road from Tyre to Palmyra, gave it ſome part of the commerce of theſe opulent capitals. Under the Romans, in the time of Auguſtus, it is mentioned as a garriſon town; and there is ſtill remaining, on the wall of the ſouthern gate, on the right as we enter, an inſcription which proves the truth of this, the words KENTURIA PRIMA, in Greek characters, being very legible. One hundred and forty years after, Antoninus built there the preſent temple, inſtead of the ancient one, which was doubtleſs falling into ruins: but Chriſtianity having gained the aſcendency under Conſtantine, the modern temple was neglected, and afterwards converted into a church; a wall of which is now remaining, that hid the ſanctuary of the idols. It continued thus until the invaſion of the Arabs, when it is probable, they envied the Chriſtians ſo beautiful a building. The church being leſs frequented fell to decay; wars ſucceeded; and it was converted into a place of defence; battlements were built on the wall which ſurrounded it, on the pavilions and at the angles, which ſtill ſubſiſt; and from that time, the temple, expoſed to the fate of war, fell rapidly to ruin. The ſtate of the city is not leſs deplorable. The wretched government of the emirs of the houſe of Harfouſhe had already greatly impared it, and the earthquake of 1759 completed its deſtruction. The wars of the Emir Youſef and Djezzar have rendered it ſtill more deſerted and ruinous. Of 5000 inhabitants, at which number they were eſtimated in 1751, not 1200 are now remaining; and all theſe poor, without induſtry or commerce, and cultivating nothing but a little cotton, ſome maize, and water-melons.

BALBINUS (Decimus Cœlius), the Roman emperor, being choſen by the ſenate in 237, was maſſacred by the ſoldiers, who had a diſlike to ſuch emperors as were elected only by the ſenators. This prince was eloquent, and wrote pretty good verſes.

BALBOA (Vaſco Nugnes de), a Caſtilian; a celebrated navigator, and one of the firſt diſcoverers of South America. He was beheaded by the Spaniſh governor of St Mary, through jealouſy of his growing reputation, in 1517, aged 42.

BALBUS (Lucius Cornelius Theophanes), was born at Cadiz, and diſtinguiſhed himſelf by his valour in the war carried on by the Romans in Spain againſt Sertorius and the Luſitanians, on which account Pompey gave him the privileges of a Roman citizen. He was conſul in the 714th year of Rome, and was the firſt foreigner on whom that dignity was conferred. He was the friend of Pompey, Cæſar, Craſſus, and Cicero.—There were many other illuſtrious Romans of the name of *Balbus*.

Balcony Baldneſs.

BALCONY, in architecture, a projecture in the front of a houſe, or other building, ſupported by pillars or conſoles, and encompaſſed with a baluſtrade.

BALDACHIN, or BALDAQUIN, in architecture, a building in form of a canopy, ſupported by pillars, and frequently uſed as a covering to inſulated altars. Some alſo uſe the term *baldachin* for the ſhell over a door.

BALDINUCCI (Philip), of Florence; a connoiſſeur in the polite arts, and the continuator of Vaſar's lives of the painters. He died in 1696, aged 72.

BALDIVIA, or VALDIVIA, a ſea-port town of Chili, in America, belonging to the Spaniards. It is ſituated between the rivers Callaculles and Portero, where they fall into the South Sea. W. Long. 80. 5. S. Lat. 40. 5. It was built in 1551 by the Spaniſh general Baldivia, from whom it takes its name. We may judge of its importance from the ſum granted annually by the king for maintaining the garriſon and keeping the fortifications in repair, being no leſs than 300,000 pieces of eight. It is defended by four ſtrong caſtles, mounting 100 pieces of fine braſs cannon. Notwithſtanding which, however, as the garriſon is compoſed moſtly of tranſported criminals, on whom no dependance can be placed, and generally ill ſupplied with ammunition, &c. it could make but a poor defence. In 1643 it was eaſily taken by the Dutch, who would probably have maintained their conqueſt againſt all the power of the Spaniſh viceroy, had they not been obliged to relinquiſh it through ſickneſs and famine. The inhabitants of Baldivia amount to about 2000. The trade is leſs conſiderable than formerly, becauſe the gold mines in the neighbourhood are ſhut up; yet ſeveral large ſhips are employed in the trade between this port and that of Lima, which conſiſts of gold, corn, hides, and ſalt proviſions, which are exchanged for ſlaves, ſugar, chocolate, and European commodities and manufactures.

BALDNESS, a defect of hair, chiefly on the ſinciput. It differs from *alopecia*, *area*, *ophiaſis*, and *tinea*, as theſe all ariſe from ſome vice in the nutritious humour; *baldneſs*, from the defect of it. When the eyelids ſhed their hair, it is called a *ptiloſis*. Among the cauſes of baldneſs, immoderate venery is reputed one of the chief: old age uſually brings it on of courſe. Some will have the proximate cauſe of baldneſs to be the dryneſs of the brain, and its ſhrinking from the cranium; it having been obſerved, that in bald perſons there is always a vacuity or empty ſpace between the ſkull and the brain.—*Calvus*, *bald-pate*, was a frequent term of reproach among the Romans; among whom this defect was in great diſcredit. Hence divers arts to conceal it, as falſe hair, a *galericulus* contrived on purpoſe. The later Romans, however, ſeem to have been

recon-

Baldoc | Bale.

reconciled to baldneſs; for we find among them a kind of officers, or ſervants, called *glabratores*, or *glabrarii*, whoſe buſineſs was to take off the hair from all parts, even from the head. In an ancient inſcription, there is mention of one Diophantus, TI. CÆSARIS ORNATOR GLABR. that is, *Ornator Glabrarius*.

BALDOC, a town of Hertfordſhire, in England, chiefly noted for its trading in malt. W. Long. 0. 10. N. Lat. 51. 55.

BALDOCK (Ralph de), biſhop of London in the reigns of Edward I. and II. was educated at Moreton-college, in Oxford; became dean of St Paul's; was afterwards promoted to the ſee of London; and at laſt was made lord high chancellor of England. He had a very amiable character both for morals and learning; and wrote *Hiſtoria Anglica*, or An Hiſtory of the Britiſh Affairs down to his own time; and, A Collection of the Statutes and Conſtitutions of the church of St Paul. Biſhop Baldock died at Stepney, July 24. 1313.

BALDWIN, archbiſhop of Canterbury, was born of obſcure parents at Exeter, where in the early part of his life, he taught a grammar-ſchool; after which he took orders, and was made archdeacon of Exeter: but he reſigned that dignity, and became a Ciſtertian monk in the monaſtery of Ford in Devonſhire, of which in a few years he was made abbot. In the year 1180, he was conſecrated Biſhop of Worceſter. In 1184, he was promoted to the ſee of Canterbury by Pope Lucius III. and, by his ſucceſſor Urban III. was appointed legate for that dioceſe. He laid the foundation of a church and monaſtery in honour of Thomas Becket, at Hackington, near Canterbury, for ſecular prieſts; but, being oppoſed by the monks of Canterbury and the Pope, was obliged to deſiſt. In 1190 he crowned King Richard I. at Weſtminſter; and ſoon after followed that prince to the holy land, where he died at the ſiege of Ptolemais. Giraldus Cambrenſis, who accompanied him in this expedition, ſays he was of a mild diſpoſition, and of great abſtinence. He wrote various tracts on religious ſubjects, which were collected and publiſhed by Bertrand Tiſſier in 1662.

BALE (John), biſhop of Oſſory in Ireland, was born at Cove, near Dunwich in Suffolk, in the year 1495. At 12 years of age he was entered in the monaſtery of Carmelites at Norwich, and was thence ſent to Jeſus-college in Oxford. He was educated a Roman catholic, but was converted to the Proteſtant religion by Thomas Lord Wentworth. On the death of Lord Cromwell, favourite of Henry VIII. who protected him from the perſecutions of the Romiſh clergy, he was obliged to retire into the Low Countries, where he continued eight years. Soon after the acceſſion of Edward VI. he was recalled; and being firſt preſented to the living of Biſhop's Stocke in Hampſhire, in 1552, he was nominated to the ſee of Oſſory. During his reſidence in Ireland he was remakably aſſiduous in propagating the Proteſtant doctrines; but to very little purpoſe, and frequently at the hazard of his life. Once, in particular, they murdered five of his domeſtics, who were making hay in a meadow near his houſe; and would probably have done the ſame by him, if the ſovereign of Kilkenny had not come to his aſſiſtance with 100 horſe and 300 foot. On the acceſſion of Queen Mary, the tide of oppoſition became ſo powerful, that, to avoid aſſaſſination, he embarked for Holland, but was very unfortunate in his eſcape. Firſt he was taken by a Dutch man of war, and robbed by the captain of all his effects. Then, being forced by ſtreſs of weather into St Ive's in Cornwall, he was confined on ſuſpicion of treaſon. Being however releaſed after a few days confinement, the ſhip anchored in Dover road, where he was again ſeized on a falſe accuſation. After his arrival in Holland, he was kept priſoner for three weeks, and at length obtained his liberty on paying 30 l. From Holland he travelled to Baſil in Switzerland, where he continued till Queen Elizabeth aſcended the throne. After his return to England, he was in 1560 made prebendary of Canterbury, probably not chooſing to return to his former flock of wolves. He died in November 1563, at Canterbury, in the 68th year of his age. He was ſo ſevere a writer againſt the church of Rome, that his books are particularly prohibited in the expurgatory index publiſhed at Madrid, in folio, in the year 1667. He is the earlieſt dramatic writer in the Engliſh language, or at leaſt author of the firſt pieces of that kind that we find in print. Of his writings in that way no fewer than 21 have been enumerated; only three of them, however, have been ſeen in print, *viz.* 1. God's Promiſes, an interlude; 2. St John Baptiſt, an interlude; 3. Concerning the Laws of Nature corrupted: the firſt of which has been reprinted by Dodſley in the firſt volume of his collection of old plays, and the only copy extant of the laſt is preſerved in St Sepulchre's library in Dublin. As to the reſt, they are mentioned by himſelf, as his own, in his account of the writers of Britain before mentioned. He alſo tranſlated the tragedies of Pammachius. His other works are very numerous; but the chief is his catalogue of Britiſh Authors: a book of ſome merit, as it contains ſome information which is not elſewhere to be found; but he has deſtroyed his credit by his intemperate Billingſgate abuſe of all thoſe who differed from him in religion. The authentic part of his work is tranſcribed from Leland. The title of it is, *Illuſtrium Majoris Britanniæ ſcriptorum catalogus, a Japheto ſanctiſſimi Noa filio ad an. Dom.* 1557.

Bale | Baleares.

BALE, in commerce. Any goods packed up in cloth, and corded round very tight, in order to keep them from breaking, or preſerve them from the weather, is called *a bale*.—A bale of cotton yarn is from 300 to 400 weight; of raw ſilk, is from 100 to 400; of lockram or dowlas, either three, three and a half, or four pieces.

Bale-goods, among the Engliſh merchants are, all ſuch as are imported or exported in bales; but the French give that name to certain hardwares, and other ſorts of merchandize, which come to Paris, and are commonly made by bad workmen of indifferent materials.

BALEARES INSULÆ, or the *Balearic Iſlands*. The apellation is commonly derived from Βαλλειν, becauſe the inhabitants were excellent ſlingers. But Bochart makes the name of Punic or Phœnician original, as were the people: *Baal-jare*, a maſter, or ſkilful at throwing; the Phœnicians and Hebrews being dexterous at the uſe of the ſling. The Greeks called theſe iſlands *Gymneſiae* (Strabo); becauſe in ſummer the inhabitants went naked (Diodorus, Livy), or rather

Balearic Islands. Balen.

ther because only armed with a ſling in war (Heſychius). They are two in number, the Greater and the Leſs, or Major and Minor; and hence the modern names *Majorca* and *Minorca*. The Major is diſtant from the Minor 30 miles to the weſt, in length 40 miles, and in circuit 150 (Pliny). They were ſubdued by Quintus Metellus, thence ſurnamed *Balearicus*, in the year 120 B. C. The Baleares, together with the adjacent iſlands, were a part of the Provincia Citerior or Tarraconenſis, and of the reſort of the Conventus Carthaginienſis of New Carthage. Theſe iſlands are called *Choearades* by Apollonius, and *Choeradades* by Strabo, *i. e.* "rocky." See MAJORCA and MINORCA.

BALEARIC ISLANDS. See the preceding article.

BALECHOU (John Joſeph), a very celebrated and well known French engraver, flouriſhed about 1750. He died, according to Baſan, ſome few years ſince at Avignon. This extraordinary artiſt worked entirely with the graver; and he was perfectly maſter of that inſtrument. The clearneſs of his ſtrokes, and the depth of colour which he produced, are far beyond any production prior to his own. The two large plates which he did from Vernet, one repreſenting a *ſtorm*, the other a *calm*, muſt ever be conſidered as very aſtoniſhing exertions of the artiſt. They are too well known, and too much admired, to need any further eulogium; and were never equalled, until they were perhaps ſurpaſſed by an Engliſhman, Mr Woollet.

BALEN (Hendrick Van), hiſtory and portrait painter, was born at Antwerp, in 1560, and was a diſciple of Adam Van Oort; but he quitted that maſter to acquire a better taſte of deſign and compoſition, by purſuing his ſtudies at Rome, where he reſided for a conſiderable time. He copied the antiques; he attended to the works of the moſt memorable modern artiſts; and at his return to his own country, the viſible improvement of his taſte recommended him to the favour and eſteem of the ableſt judges of the art. He diſtinguiſhed himſelf by a good manner of deſigning, and his works are admitted into the cabinets of the curious, among thoſe of the principal painters. He particularly excelled in the naked, and gave to his figures ſo much truth, roundneſs, and correctneſs of outline, that few of his cotemporaries could enter into competition with him. Several fine portraits of his hand are at the Hague; among which there is one adorned with allegorical figures of Wiſdom and Juſtice, which extorts commendation from all who attentively conſider it. He died in 1632. All the hiſtorical ſubjects painted by Van Balen have abundant merit. His deſigns of the Deluge, of Moſes ſtriking the Rock, and the drowning of Pharaoh, are grand and noble compoſitions. Houbraken obſerves, that Van Balen, with great judgment, hath introduced the Iſraelites in a clear light in the back-ground, but the Egyptians in a ſtrong ſhadow in the fore-ground, which had a very fine effect; the figures being well deſigned, the attitudes and draperies well choſen, and the number of the figures being very conſiderable. Of this painter's hand alſo, the judgment of Paris is accounted a maſterly performance; in which the figure of Venus is ſo elegantly deſigned, ſo full of life, and ſo round, that it ſeems to ſtand forth from the ſurface. The landſcapes and back-grounds of the pictures compoſed by Van Balen, were generally painted by the Velvet Breughel. Balen, Bales.

BALEN (John Van), painter of hiſtory, landſcapes, and boys, was born at Antwerp in 1611; and derived his knowledge of the art, and his fine taſte of drawing and deſign, from his father Hendrick Van Balen; but, as ſoon as he had made a competent progreſs, he travelled to Rome, and lived for ſeveral years in that and other cities of Italy. There he acquired a good guſto of deſign, though he was ſometimes incorrect; and his particular merit was ſhown in his naked figures of boys, cupids, nymphs bathing or hunting, of which ſubjects he painted a conſiderable number; and he procured both praiſe and riches by his landſcapes and hiſtories. His pictures were well handled, his trees touched with ſpirit, and his herbage and verdure looked natural and lively. The carnations of his figures were clear and freſh; his colouring in general was tranſparent; and the airs of his heads were in the manner of Albano.

BALES (Peter), a very extraordinary perſon in his way, and fit to be recorded in a work of this nature. He was a moſt famous maſter in the art of Penmanſhip, or fair writing; and one of the firſt inventors (for there ſeems to have been more than one) of ſhort-hand writers. He was born in 1547, and is ſtyled by Anthony Wood "a moſt dexterous perſon in his profeſſion, to the great wonder of ſcholars and others:" who adds, that "he ſpent ſeveral years in ſciences among the Oxonians, particularly as it ſeems in Glouceſter hall: but that ſtudy, which he uſed for a diverſion only, proved at length an employment of profit." He is recorded for his ſkill in micrography, or miniature-writing, in Hollinſhed's Chronicle, anno 1575; and Mr Evelyn alſo hath celebrated his wonderful ſkill in this delicate operation of the hand. "Hadrian Junius ſpeaking as a miracle of ſomebody, who wrote the Apoſtle's Creed, and the beginning of St John's Goſpel, within the compaſs of a farthing; what would he have ſaid," ſays Mr Evelyn, "of our famous Peter Bales; who in the year 1575, wrote the Lord's Prayer, the Creed, Decalogue, with two ſhort prayers in Latin, his own name, motto, day of the month, year of the Lord, and reign of the Queen, to whom he preſented it at Hampton Court, all of it written within the circle of a ſingle penny, inchaſed in a ring and borders of gold; and covered with a chryſtal ſo accurately wrought, as to be very plainly legible, to the great admiration of her Majeſty, the whole Privy Council, and ſeveral ambaſſadors then at Court?" He was farther very dexterous in imitating hand-writing, and, about 1586, was employed by Secretary Walſingham in certain political manœuvres. We find him at the head of a ſchool, near the Old Bailey, London, in 1590; in which year he publiſhed his "Writing Schoolmaſter, in three parts: the firſt teaching ſwift writing, the ſecond, true writing, the third, fair writing." In 1595, he had a great trial of ſkill in the Black-friars with one Daniel Johnſon, for a golden pen of 20 l. value, and won it; and a contemporary author farther relates, that he had alſo the arms of Caligraphy given him, which are Azure, a Pen, Or, as a prize, at a trial of ſkill in this art among the beſt penmen in London. In 1597, he republiſhed his "Writing Schoolmaſter,"

Baleſtra, Baley.

Schoolmaſter," which was in ſuch high reputation, that no leſs than eighteen copies of commendatory verſes, compoſed by learned and ingenious men of that time, were printed before it. Wood ſays, that he was engaged in Eſſex's treaſons in 1600; but Wood was miſtaken: he was only engaged, and very innocently ſo, in ſerving the treacherous purpoſes of one of that Earl's mercenary dependents. We know little more of this curious perſon, but that he ſeems to have died about the year 1610.

BALESTRA (Antonio), an excellent hiſtorical painter, was born at Verona in 1666. At the age of 21 he went to Venice, where he entered himſelf in the ſchool of Antonio Bellucci, and continued for three years under his direction; but from thence he viſited Bologna and Rome, and at the latter became the diſciple of Carlo Maratti. Under the tuition of ſo eminent a genius, he made a very great proficiency, and exerted himſelf for ſome hours of each day, in deſigning after the antiques, after Raphael, Correggio, Annibal Carracci and other admired painters; by which conduct he ſo effectually confirmed his taſte and freedom of hand, that he obtained the prize of merit in the academy of St Luke, in the year 1694, when he was only 28 years of age. From that time his reputation was eſtabliſhed, and he received ſufficient encouragement; being engaged to work for moſt of the churches, and in the palaces of the nobility, and his paintings were admired in every part of Europe. His ſtyle is ſweet and agreeable, not unlike that of Maratti; and the judicious obſerve in the works of Baleſtra, a certain mixture of the ſeveral manners of Raphael, Correggio, and Carracci. He died in 1740. In the Church of Santa Maria Mater Domini at Venice, there is one of the moſt capital performances of Baleſtra, repreſenting the nativity of our Saviour. It is deſigned in a grand ſtyle, the compoſition is excellent, and has a great deal of grace. The heads are peculiarly fine; and the whole has a noble effect, with remarkable harmony. In a chapel belonging to the church of S. Geminiano, in the ſame city, there is a dead Chriſt in the arms of the Virgin, painted by this maſter in a grand taſte; and although the compoſition conſiſts but of a few figures, they are finely deſigned; and in every part of it there is a ſufficient merit to claim and juſtify applauſe.

BALEY (Walter), the ſon of Henry Baley of Warnwell in Dorſetſhire, was born at Potſham in the ſame county, and educated at Wincheſter ſchool. From thence he was ſent to Oxford; and, after two years probation, was admitted perpetual fellow of New College in the year 1550. Having taken his degrees in arts, he practiſed phyſic, and in 1558 was proctor of the univerſity. About this time he obtained a prebend of Wells, which he reſigned in 1579. In the year 1561 he was appointed queen's profeſſor of phyſic, in 1563 proceeded doctor in that Faculty, and afterwards became one of her majeſty's phyſicians in ordinary. He was thought ſkilful in his profeſſion, and had conſiderable practice. He died in 1592, aged 63; and was buried in the inner chapel of New College. His works are, 1. *A diſcourſe of three kinds of pepper in common uſe*, 1588, 8vo. 2. *Brief treatiſe of the preſervation of the eye-ſight*. Firſt printed in the reign of Elizabeth, in 12mo; afterwards at Oxford in 1616 and 1654, 8vo. 3. *Directions for health, natural and artificial; with medicines for all diſeaſes of the eyes*, 1626, 4to. 4. *Explicatio Galeni de potu convalaſcentium et ſenum*, &c. manuſcript, formerly in Lord Ayleſbury's library.

Bali ‖ Baliſtes.

BALI, an iſland of Aſia, in the Eaſt-Indies, forming the north ſide of the ſtraits of Java, through which the Eaſt-India ſhips ſometimes return from China to Europe: but the paſſage is commonly difficult on account of contrary winds. The iſland is extremely populous, and abounds in rice and other productions proper to the climate. The inhabitants are Pagans, and very warlike. E. Long. 115. 30. S. Lat. Lat. 9. 0.

BALIOL, or BALLIOL, (Sir John de), founder of Baliol-college, in Oxford, was the ſon of Hugh Baliol, of Bernard's caſtle, in the dioceſe of Durham; and was a perſon very eminent for his power and riches. During the conteſts and wars between King Henry III. and his barons, he firmly adhered to the king. In 1263, he began the foundation and endowment of Baliol-college, which was afterwards perfected by his widow. He died in the year 1269.

BALIOL, BALLIOL, or BOILLIOL, (John), the brother of Alexander king of Scotland, and competitor with Robert Bruce for that crown. See SCOTLAND.

BALISORE, a ſea-port town of Aſia, in the Eaſt Indies, to the northweſt of the bay of Bengal. It is about four miles from the ſea by land, but 20 by the river; ſeated in a very fruitful ſoil, producing rice, wheat, aromatic ſeeds, tobacco, &c. The inhabitants make ſeveral ſort of ſtuffs of cotton, ſilk, and a kind of graſs. The Engliſh, French, and Dutch, have factories here; but they are now of no great account. E. Long. 85. 20. N. Lat. 21. 30.

BALISTES, in ichthyology, a genus of fiſhes belonging to the order of amphibia nantes. The characters are theſe: The head is flat; there are eight teeth in each ſide, and the two anterior ones are longeſt; in the place of gills, the baliſtes has an aperture immediately above the pectoral fins; the body is flat, the ſcales are joined together by the ſkin, and the belly is keeled. The ſpecies of this genus are eight, *viz.* 1. The monoceros, whoſe head-fin conſiſts of but one ray, and the tail-rays are carinated. It is called the *unicorn-fiſh* by Cateſby; who informs us, that the guts of this fiſh are full of ſmall ſhells and coralline ſubſtances, which by the ſtrength and hardneſs of its jaws it is enabled to grind very ſmall. Theſe fiſh, he adds, are not eat, being accounted poiſonous. They moſt frequent thoſe ſeas, amongſt the Bahama iſlands, where the corals are in great plenty. 2. The hiſpidus, whoſe head-fin is uniradiated; and there is a round black ſpot in the tail-fin. The body is rough, and briſtly towards the tail. The ſpine or horn is ſituated between the eyes; the ſnout is ſubulated; and inſtead of a belly-fin, it has a jagged ſharp ſpine. This ſpecies is a native of Carolina. 3. The tomentoſus, whoſe head fin is biradiated, and the body of it towards the hind part is hairy. It is a native of America. 4. The papilloſus, has a biradiated back-fin, and a papillous body. 5. The verrucoſus, has a triradiated back-fin; and the tail is full of little warts. In the place of a belly-fin, this ſpecies has a large, thick, warty ray. It has 25 ſmall reverſed ſharp ſpines at the ſide of the tail, diſpoſed in four rows. It is a native of India. 6. The

Baliyo, Balk.

aculeatus has a triradiated back-fin; and the ſpines of the tail lean upon each other. It is alſo a native of India. 7. The vetula, or old wife, has a triradiated back-fin; the belly-fin is longitudinal, and ſomewhat carinated; and the tail-fin is forked. It is found at Aſcenſion iſland. 8. The ringens, has a triradiated back-fin; there are three folds on each ſide of the head, and the tail-fin is forked. This ſpecies is likewiſe found at Aſcenſion iſland.

BALIVO AMOVENDO, in law, was a writ for removing a bailiff from his office, for want of having ſufficient land in his bailiwick to anſwer the king and his people, according to the ſtatute of Weſtminſter, 2 reg. Orig. 78.

BALK, among builders, is ſometimes uſed for the ſummer-beam of a houſe; ſometimes for the poles and rafters, which ſupport the roofs of barns, &c.; and ſometimes for the beams uſed in making ſea-holds.

BALK, or *Balkh*, a province of Great Buckharia in Aſia, about 360 miles long and 250 broad, ſituated to the ſouth of the province of Samarkand, and to the eaſt of Bukharia Proper. It is the leaſt of the three provinces that make up what is called *Great Buckharia*; but being extremely fertile and well cultivated, the prince draws a great revenue from it. The country particularly abounds with ſilk, of which the inhabitants make pretty manufactures. The Uzbecks ſubject to the khan of Balkh are the moſt civilized of all the Tartars inhabiting Great Bukharia, owing probably to their commerce with the Perſians: they are likewiſe more induſtrious, and more honeſt, than the reſt; but in other reſpects have the ſame cuſtoms with the reſt of the Tartars. The province is ſubdivided into ſeveral counties; the moſt remarkable of which are Khotlan or Katlan, Tokhareſtan, and Badagſhan. Its chief cities are Balk, Fariyab, Talkhan, Badagſhan, and Anderab.

BALK, the capital of the abovementioned province, ſituated on the frontiers of Perſia, in E. Long. 65. 20. N. Lat. 37. 0. It is probably the ancient Bactra, capital of the kingdom of Bactria; and is ſaid by the Perſians to have been founded by Kay-umarraz the firſt king of Perſia, becauſe he met his brother upon the ſpot where it ſtood, after he had been loſt for a long time; *balkhiden*, or *balghiden*, in the Perſic language, ſignifying to receive and embrace a friend. The firſt kings of Perſia who reſided in the province of Media or *Aderbijan*, conſidered this city as one of their principal frontiers on the ſide of Scythia. In the 27th year of the Hegira, of Chriſt 647, Balk was reduced by the Arabs, under the command of Abdallah Ebn Amer. It continued ſubject to Arab princes till the year of the Hegira 432, of Chriſt 1041; when it was reduced by Togrol Beg, the Tangrolipix of the Greeks, and prince of the Seljukian dynaſty. It was taken by Jenghiz Khan, A. D. 1221, who with his uſual and unparalleled cruelty cauſed all the inhabitants to be brought without the walls and maſſacred without mercy. In 1369, Sultan Hoſein, the laſt of the race of Jenghiz Khan was driven from Balkh by Tamerlane, whoſe ſucceſſors were driven out by the Uzbecks in the 15th century. It was afterwards redeemed by Shah Iſmael Sufi; but finally wreſted out of his hands by the Uzbeck Tartars, between whom and the Perſians it is the occaſion of almoſt continual wars. It was, not long ſince, the reſidence of a khan of Tartars. It is the moſt conſiderable city poſſeſſed in theſe parts by the Mahometan Tartars, is large, well built and populous, the houſes conſiſting for the moſt part of ſtone or brick. The fortifications conſiſt of bulwarks of earth, fenced without with a ſtrong wall high enough to cover the ſoldiers employed in defence of thoſe fortifications. As this place is the reſort of all the buſineſs tranſacted between the Indies and Great Bukharia, trade flouriſhes extremely at Balkh; eſpecially as it has a fine river paſſing through its ſuburbs, which is of vaſt ſervice to the town. This river falls into the Amu, in N. Lat. 38. 30. upon the confines of Great Bukharia and Kowarazm. The khan's palace, or caſtle, is a large edifice built after the oriental manner; and conſiſts almoſt entirely of marble, of which there are fine quarries in the neighbourhood. The khan of Balk, however, was obliged in 1739 to ſubmit to the Perſians under Khouli Kan; but ſince that time has moſt probably regained his independency.

Balkers. Ball.

BALKERS, in the fiſhery, perſons placed on rocks, and eminences at ſea, to ſpy the herring droves, and give notice to the fiſhermen, by waving boughs, what way they go, and where they may be found.

BALL, in a general ſenſe, a ſpherical and round body, whether naturally ſo, or formed into that figure by art.

BALL, in the military art, comprehends all ſorts of bullets for fire-arms, from the cannon to the piſtol. Cannon-balls are of iron; muſket-balls, piſtol-balls, &c. are of lead. The experiment has been tried of iron balls for piſtols and fuſees; but they are juſtly rejected, not only on account of their lightneſs, which prevents them from flying ſtraight, but becauſe they are apt to furrow the barrel of the piſtol, &c.

BALL of a Pendulum, the weight at the bottom. In ſhorter pendulums, this is called the *bob*.

BALL, in pyrotechnics, is alſo a compoſition of various combuſtible ingredients, ſerving to burn, ſmoke, give light, &c. In this ſenſe we read of fire-balls, light-balls, ſmoke-balls, ſtink-balls, ſky-balls, water-balls, land-balls.

BALL, among the Corniſh miners, ſignifies a tin-mine.

BALL, among printers, a kind of wooden tunnel ſtuffed with wool, contained in a leather cover, which is nailed to the wood, with which the ink is applied on the forms to be wrought off. See PRINTING.

Horſe-BALLS, among farriers. Horſes have a very nice taſte; it is therefore proper to give the more diſagreeable drugs in the form of balls, and to make drenches of the more palatable. Balls ſhould be of an oval ſhape, not exceeding the ſize of a pullets egg; and ſhould be dipped in ſweet oil to make them ſlip down the eaſier. Some horſes have a ſtrait gullet, which makes them very averſe to a ball being thruſt down their throats; ſuch horſes had better have drenches given them, or their medicines may be mixed with bran, or in their maſhes. See FARRIERY, *Paſſim*.

BALL Vein, in mineralogy, a name given by the miners of Suſſex to a ſort of iron ore, common there, and wrought to conſiderable advantage. It yields not any great quantity of metal, but what it has runs freely in

Ball. in the fire; it is uſually found in looſe maſſes, not in the form of a ſtratum, and is often covered with one or more cruſts. It generally contains ſome ſparkling particles; and is uſually of a circular form in the perfect maſſes, thickeſt in the middle, and gradually thinner as it approaches the ſides. The ores of Suſſex in general are poor, but they require very little trouble in the working; ſo that a conſiderable profit is made annually from them.

Ball and Socket is an inſtrument made of braſs, with a perpetual ſcrew, ſo as to move horizontally, vertically, and obliquely; and is generally uſed for the managing of ſurveying and aſtronomical inſtruments.

Puff-Ball, the Engliſh name of the lycoperdon. See Lycoperdon.

Martial Balls, in pharmacy, are a mixture of filings of iron and cream of tartar, formed into a ſolid conſiſtence and form of a ball, which is uſed to impregnate water or other liquids with iron diſſolved by the tartareous acid. To make theſe balls, one part of filings of iron and two parts powdered cream of tartar are mixed well together, and put into an earthen or iron veſſel with ſome water. The mixture is to be ſtirred from time to time till it becomes almoſt dry; and then it is to receive more water, and to be ſtirred as before. This treatment is to be continued till it acquires, when nearly dry, ſomewhat of the conſiſtence and tenacity of ſoftened roſin. Then it is to be rolled up in the form of a ball, which is generally kept tied up in a rag; and when intended to be uſed, it is to be infuſed in water, till it gives ſome colour to that liquid. The infuſion of martial balls is tonic, vulnerary, diſcutient and aperitive; and is employed both internally and externally*. Iron being ſoluble in all acids, is attacked in this preparation by the tartareous acid, which reduces it to a kind of neutral ſalt not cryſtallizable. This ſalt would remain liquid, and would form a ſoluble martial tartar, called *tartariſed tincture of Mars*. If proper proportions of filings of iron and cream of tartar be uſed, and treated long enough for an entire and complete combination, nothing would be obtained but a liquor or magma, which could not be preſerved in a ſolid form, but would be continually moiſt. Therefore, in the martial ball there is a good deal of the cream of tartar and filings of iron not combined together, by which its ſolidity is preſerved.

*See *Iron*.

Mercurial Balls, in pharmacy, are an amalgam of mercury and tin, ſufficiently ſolid to be moulded, and to preſerve a given form. The method of making them is by adding mercury to melted tin, and pouring the fluid maſs into a round hollow mould.—Theſe balls are employed to purify water, in which they are boiled; for which purpoſe travellers often carry ſome along with them. Nothing, however, can be more pernicious than ſuch a practice, ſhould the water contain any nitrous acid, which it very often does.

Balls of Silk worms and Spiders, are little caſes or cones of ſilk, wherein thoſe inſects depoſite their eggs. Spiders are extremely tender of their balls, which they carry about with them adhering to the papillæ about their anus. Grew mentions balls or bags of a ſpecies of ſilk-worms in Virginia, as big as hens eggs, and containing each four aurelias.

Zoologiſts ſpeak of a ſort of balls of hair covered over with a ſmooth ſhining coat, or ſhell found in the ſtomachs of oxen, cows, calves, horſes, ſheep, and goats. See the article Bezoar. Ball.

Balls of Fire, in meteorology. See Fire (*Balls of*).

Balls in electricity, are two pieces of cork, or pith of elder, nicely turned in a lathe to the ſize of a ſmall pea, and ſuſpended by fine linen threads; intended as electrometers, and of excellent uſe to diſcover ſmall degrees of electricity, to obſerve the changes of it from poſitive to negative, and *vice verſa*; and to eſtimate the force of a ſhock before the diſcharge, ſo that the operator ſhould always be able to tell very nearly before the diſcharge, by knowing how high he has charged his jars, what the exploſion will be.

Fire-Balls, are bags of canvas filled with gunpowder, ſulphur, ſaltpetre, pitch, &c. to be thrown by the ſoldiers, or out of mortars, in order to fire the houſes incommoding trenches, advanced poſts, or the like.—The Greeks had divers kinds of fire-balls, or πυροβολοι λιθοι; one kind called more particularly, σκυταλια, or σκυταλιδες, made of wood, ſometimes a foot, or even a cubit long; their heads being armed with ſpikes of iron, beneath which were hemp, pitch, and other combuſtibles, which being ſet on fire, they were caſt among the enemy. The preparations of fire-balls, among the moderns, conſiſt of ſeveral operations, viz. making the bag, preparing the compoſition, tying, and, laſtly, dipping the ball. 1. The bags for this purpoſe are either oval or round. 2. The compoſition wherewith fire-balls are filled is various: To ten pounds of meal-gunpowder add two of ſaltpetre, one of ſulphur, and one of colophony; or, to ſix pounds of gunpowder, add four of ſaltpetre, four of ſulphur, one of powdered glaſs, half a pound of antimony, as much camphor, an ounce of ſal-ammoniac, and four of common ſalt, all pulveriſed. Sometimes they even fill fire-balls with hand granadoes. 3. For tying the fire-balls, they prepare two iron rings, one fitted round the aperture, where the ball is to be lighted, the other near its baſe. A cord is tied to theſe rings in ſuch a manner, as that the ſeveral turns repreſent ſemicircles of the ſphere cutting the globe through the poles: over the cords, extended according to the length of the ball, others are tied, cutting the former at right angles, and parallel to each other, making a knot at each interſection: laſtly, after putting in a leaden bullet, the reſt of the ſpace is filled with tow or paper. 4. Thus completed, the fire-ball remains to be dipped in a compoſition of melted pitch four pounds, colophony two, and linſeed oil or oil of turpentine two; after dipping, they cover it round with tow, and dip again, till it be brought to the juſt diameter required.

Light-Balls, are ſuch as diffuſe an intenſe light around; or they are balls which, being caſt out of the hand or a mortar, burn for ſome time, and illuminate the adjacent parts. 1. Luminous or light-balls for the hand, are made of ground powder, ſaltpetre, brimſtone, camphor, and borax, all ſprinkled with oil, and moulded into a maſs with ſuet; and this is wrapped up in tow, with a ſheet of ſtrong paper over it. To fire it, they make a hole into it with a bodkin, into which they put ſome priming that will burn ſlow. Its uſe is to be caſt into any works they would diſcover in the night-time. 2. For the larger light-balls, or

Ball
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Ballad.

those to be thrown to a greater distance, they melt equal quantities of sulphur, turpentine, and pitch; and herein dip an earthen or stone-ball, of a diameter much less than that of the mortar out of which the fire-ball is to be cast; then rolling it in gun-powder, and covering it round with gauze, they dip it again, and repeat the rest till it come to fit the cavity of the mortar: lastly, they sprinkle it around with gun-powder. This, being once kindled, will strongly illuminate all around the place where it is thrown, and give opportunity to examine the state and condition thereof.

Smoke or Dark BALLS, those which fill the air with smoke, and thus darken a place to prevent discoveries. To prepare a darkening ball, make an oval or spherical bag, melt rosin over the coals, and add an equal part of saltpetre not purified, also of sulphur, and a fifth part of charcoal. The whole being well incorporated, put in tow first shred, and fill the bags with this composition, and dip it after the same manner as a fire-ball.

*Stink-*BALLS, those which yield a great stench where fired to annoy the enemy. Their preparation is thus: Melt ten pounds of pitch, six of rosin, twenty of saltpetre, eight of gun-powder, and four of colophony; to these add two of charcoal, six of horse-hoofs cut small, three of assafœtida, one of stinking-saracen, and any other offensive ingredients. The rest as in the former.

*Sky-*BALLS, those cast on high out of mortars, and which, when arrived at their height, bursting like rockets, afford a spectacle of decoration. Sky-balls are made of a wooden shell, filled with various compositions particularly that of the stars of rockets. These are sometimes intermixed with crackers and other combustibles, making rains of fire, &c.

*Water-*BALLS, those which swim and burn a considerable time in the water, and at length burst therein. These are made in a wooden shell, the cavity of which is filled with refined saltpetre, sulphur, saw-dust boiled in water of saltpetre, and dried; to which sometimes other ingredients are added, as iron-filings, Greek pitch, amber dust, powdered glass, and camphor. The ingredients are to be ground, mixed up, and moistened with linseed oil, nut oil, olive oil, hempseed oil, or petrol. At the bottom is placed an iron coffin, filled with whole gunpowder, that the ball may at last burst with a greater noise: and, lastly, the ball is, by the addition of lead or otherwise, made of the same specific gravity with water.

*Land-*BALLS are those which, being thrown out of a mortar, fall to the ground, burn, and burst there. The ingredients are much the same as in the *water-balls*, only the specific gravity is not attended to.

BALLAGHAN, a town of Ireland, in the county of Sligo, and province of Connaught. W. Long. 9. 50. N. Lat. 53. 48.

BALLAN, a town of France, in the diocese of Mons, with the title of a marquisate, seated on the river Orne. E. Long. 0. 20. N. Lat. 48. 10.

BALLAD, a kind of song, adapted to the capacity of the lower class of people; who, being mightily taken with this species of poetry, are thereby not a little influenced in the conduct of their lives. Hence we find, that seditious and designing men never fail to spread ballads among the people, with a view to gain them over to their side. Ballast.

BALLAST, an heavy matter, as stone, gravel, iron, &c. thrown into the hold of a ship, in order to make her sink a proper depth in the water, that she may be capable of carrying a sufficient quantity of sail without oversetting.

There is often great difference in the proportion of ballast required to prepare ships of equal burden for a voyage; the quantity being always more or less according to the sharpness or flatness of the ship's bottom, which seamen call the *floor*.

The knowledge of ballasting a ship with propriety, is certainly an article that deserves the attention of the skilful mariner: for although it is known, that ships in general will not carry a sufficient quantity of sail till they are laden so deep that the surface of the water will nearly glance on the extreme breadth amidships, yet there is more than this general knowledge required; since, if she has a great weight of heavy ballast, as lead, iron, &c. in the bottom, it will place the centre of gravity too low in the hold; and although this will enable her to carry a great sail, she will nevertheless sail very heavily, and run the risk of being dismasted by her violent rolling.

To ballast a ship, therefore, is the art of disposing those materials so that she may be duly poised, and maintain a proper equilibrium on the water, so as neither to be too *stiff* nor too *crank*, qualities equally pernicious: as in the first, although the ship may be fitted to carry a great sail, yet her velocity will not be proportionably increased; whilst her masts are more endangered by her sudden jerks and excessive labouring: and in the last, she will be incapable of carrying sail, without the risk of oversetting.

Stiffness, in ballasting, is occasioned by disposing a great quantity of heavy ballast, as lead, iron, &c. in the bottom, which naturally places the centre of gravity very near the keel; and that being the centre, about which the vibrations are made, the lower it is placed, the more violent will be the motion of rolling.

Crankness, on the other hand, is occasioned by having too little ballast, or by disposing the ship's lading so as to raise the centre of gravity too high, which also endangers the mast in carrying sail when it blows hard: for when the masts lose their perpendicular height, they strain on the shrouds in the nature of a lever, which encreases as the sine of their obliquity; and a ship that loses her masts is in great danger of being lost.

The whole art of ballasting, therefore, consists in placing the centre of the gravity to correspond with the trim and shape of the vessel, so as neither to be too high nor too low; neither too far forward nor too far aft, and to sade the ship so deep, that the surface of the water may nearly rise to the extreme breadth amidships; and thus she will be enabled to carry a good sail, incline but little, and ply well to the windward.

Ships are said to be *in ballast* when they have no other loading. Masters of vessels are obliged to declare the quantity of ballast they bear, and to unload it at certain places. They are prohibited unloading their ballast in havens, roads, &c. the neglect of which has

ruined

Ballatoons Balliconnel

ruined many excellent ports.—Ships and veſſels taking in ballaſt in the river Thames, are to pay ſo much a tun to Trinity-houſe, Deptford; who ſhall employ ballaſtmen, and regulate them; and their lighters to be marked, &c. on pain of 10l.

BALLATOONS, large heavy luggage-boats uſed for carrying wood by the river from Aſtracan and the Caſpian ſea from Moſcow. Theſe will carry from 100 to 200 ton, and have from 100 to 120 men employed to row and tow them along.

BALLENDEN (Sir John), a Scottiſh poet, in the reign of James V. of Scotland, was deſcended from an ancient family in that kingdom. His father, Mr Thomas Ballenden of Auchinoul, was director to the chancery in the year 1540, and clerk-regiſter in 1541. Where our poet was educated, we are not informed; but from one of his poems we learn, that in his youth he had ſome employment at the court of king James V. and that he was in great favour with that prince. Having taken orders, and being created doctor of divinity, at the Sorbonne, he was made canon of Roſs, and archdeacon of Murray. He likewiſe obtained the place of clerk-regiſter, but was afterwards deprived of that employment by the factions of the times; however, in the ſucceeding reign, of Mary, he recovered that office, and was one of the lords of ſeſſion. Being a zealous papiſt, he, in conjunction with Dr Laing, was extremely aſſiduous in retarding the progreſs of the reformation; till at laſt, finding the oppoſition too powerful, he quitted Scotland, and went to Rome, where he died in the year 1550. He is generally eſteemed one of the beſt Scottiſh poets of that age. His works are, 1. *The hiſtory and chronicles of Scotland of Hector Boëis* (Boethius), *tranſlated by Mr John Ballenden*, Edinb. 1536. This is not a mere traſlation, Ballenden having corrected ſeveral miſtakes of his author, and made large additions. It is in folio, and black letter. 2. *Coſmography to the hiſtory of Scotland*, with a poetical proem. 3. *A deſcription of Albany*. 4. *Tranſlation of Boethius's deſcription of Scotland*. 5. *Epiſtles to king James* V. Bale ſays he had ſeen theſe letters. 6. Several poems in Carmichael's collection of Scottiſh poems; beſides many others in manuſcript, in private libraries in Scotland. 7. *Virtue and vyce*, a poem addreſſed to king James V.

BALLET, Balet, or Baletto, a kind of dramatic poem, repreſenting ſome fabulous action or ſubject divided into ſeveral entries; wherein ſeveral perſons appear, and recite things under the name of ſome deity, or other illuſtrious character.

Ballet is more particularly uſed for a kind of comic dance, conſiſting of a ſeries of ſeveral airs of different kinds of movements, which together repreſent ſome ſubject or action. They are performed chiefly by maſks repreſenting ſylvans, tritons, nymphs, ſhepherds, and the like; and conſiſt of three parts, the entry, figure, and the retreat. The word is of Greek origin, formed from βαλλειν, *jacere*, to caſt, throw, or toſs; whence alſo in writers of the middle age, we find *ballationes* for *ſaltationes*, dancings; and *ballare* for *ſaltare*, to dance.

BALLIAGE, or Bailiage, in commerce, a ſmall duty paid to the city of London by aliens, and even denizens, for certain commodities exported by them.

BALLICONNEL, a town of Ireland, in the county of Cavan, and province of Ulſter. W. Long. 7. 45. N. Lat. 54. 6. Ballishannon Balloon.

BALLISHANNON, a large town of Ireland, in the county of Donegal, or Tyrconnel, with a good haven. W. Long. 8. 25. N. Lat. 54. 25.

BALLISTA, a machine uſed by the ancients for ſhooting darts; it reſembled in ſome meaſure our croſs-bow. The word is Latin, ſignifying a croſs-bow; and is derived from the Greek, βαλλω, to *ſhoot*, or *throw*.

Vegetius informs us, that the balliſta diſcharged darts with ſuch rapidity and violence, that nothing could reſiſt their force: and Athenæus adds, that Agiſtratus made one of little more than two feet in length, which ſhot darts 500 paces.

In Plate XCVII. is repreſented the balliſta uſed in ſieges, according to the chevalier Folard: 2, 2, the baſe of the balliſta; 3, 4, upright beams; 5, 6, tranſverſe beams; 7, 7, the two capitals in the upper tranſverſe beam, (the lower tranſverſe beam has alſo two ſimilar capitals, which cannot be ſeen in this tranſverſe figure); 9, 9, two poſts or ſupports for ſtrengthening the tranſverſe beams; 10, 10, two ſkains of cords faſtened to the capitals; 11, 11, two arms inſerted between the two ſtrands, or parts of the ſkains; 12, a cord faſtened to the two arms; 13, darts which are ſhot by the balliſta; 14, 14, curves in the upright beams, and in the concavity of which cuſhions are faſtened, in order to break the force of the arms which ſtrike againſt them with great force when the dart is diſcharged; 16, the arbor of the machine, in which a groove or canal perfectly ſtraight is formed, and in which the darts are placed in order to their being ſhot by the balliſta; 17, the nuts of the trigger; 18, the roll or windlaſs, about which the cord is wound; 19, an hook, by which the cord is drawn towards the centre, and the balliſta cocked; 20, a ſtage or table on which the arbor is in part ſuſtained.

BALLISTEUM, or Ballistræa, in antiquity, a military ſong or dance uſed on occaſions of victory. Vopiſcus has preſerved the *balliſteum* ſung in honour of Aurelian, who, in the Sarmatian war, was ſaid to have killed 48 of the enemy in one day with his own hand. *Mille, mille, mille, mille, mille, mille decollavimus: Unus homo mille, mille, mille, mille decollavit; mille, mille, mille vivat, qui mille, mille occidit. Tantum vini habet nemo, quantum fudit ſanguinis.* The ſame writer ſubjoins another popular ſong of the ſame kind: *Mille Francos, mille Sarmatas, ſemel occidimus; mille, mille, mille, mille, mille Perſas quærimus.* It took the denomination *balliſteum* from the Greek βαλλω *jacio*, or *jacto*, to caſt or toſs, on account of the motions uſed in this dance, which was attended with great elevations and ſwingings of the hands. The *balliſtea* were a kind of popular ballads, compoſed by poets of the lower claſs, without much regard to the laws of metre.

BALLOON, or Ballon, in a general ſenſe, ſignifies any ſpherical hollow body, of whatever matter it be compoſed, or for whatever purpoſes it be deſigned. Thus, with chemiſts, balloon denotes a round ſhort-necked veſſel, uſed to receive what is diſtilled by means of fire; in architecture, a round globe on the top of a pillar; and among engineers, a kind of bomb made of paſteboard, and played off in fire-works, either in the air or on the water, in imitation of a real bomb.

Balloon || Balls.

*Air-*BALLOON. See AEROSTATION and *Air-balloon*.

BALLOON alſo denotes a kind of game ſomething reſembling tennis. The balloon is played in the open field, with a great round ball of double leather blown up with wind, and thus driven to and fro with the ſtrength of a man's arm, fortified with a brace of wood.

BALLOON, or BALLOEN, is more particularly uſed among voyagers for the ſtate-barges of Siam. The balloons are a kind of brigantine, managed with oars, of very odd figures, as ſerpents, ſea-horſes, &c. but, by their ſharpneſs and number of oars, of incredible ſwiftneſs. The balloons are ſaid to be made of a ſingle piece of timber, of uncommon length; they are raiſed high, and much decorated with carving at head and ſtern: ſome are gilt over, and carry 120 or even 150 rowers on each ſide. The oars are either plated over with ſilver, or gilt, or radiated with gold; and the dome or canopy in the middle, where the company is placed, is ornamented with ſome rich ſtuff, and furniſhed with a balluſtrade of ivory, or other coſtly matter, enriched with gilding. The edges of the balloon juſt touch the water, but the extremities riſe with a ſweep to a great height. Some are adorned with variety of figures, made of pieces of mother of pearl inlaid: the richer ſort, inſtead of a dome, carry a kind of ſteeple in the middle; ſo that, conſidering the ſlenderneſs of the veſſel, which is uſually 100 or 120 feet long, and ſcarce ſix broad, the height of the two ends, and of the ſteeple, with the load of decorations, it is a kind of miracle they are not overſet.

BALLOON, in the French paper-trade, is a term for a quantity of paper, containing 24 reams.

BALLOON, BALLON, or BALLOT, in the French glaſs-trade, ſignifies a certain quantity of glaſs-plates, ſmaller or greater according to their quality. The ballon of white glaſs contains 25 bundles, of ſix plates per bundle; but the ballon of coloured glaſs is only of $12\frac{1}{2}$ bundles, and of three plates to a bundle.

BALLOTA, WHITE HOREHOUND: A genus of the gymnoſpermia order, belonging to the didynamia claſs of plants: and in the natural method ranking under the 42d order, *Verticillatæ*. The calyx has 5 teeth, with 10 ſtriæ; and the upper lip of the corolla is crenated. It is a common weed growing on the ſides of banks in moſt parts of England, as alſo in walk-places near towns and villages in Scotland; ſo is ſeldom admitted into gardens. The flowers grow in whorls, upon branched peduncles, and lean on one ſide of the ſtalk; they are commonly of a dull red colour, but ſometimes white. It was formerly uſed in hyſteric caſes, but is now fallen into diſuſe. The Swedes reckon it almoſt an univerſal remedy in the diſeaſes of their cattle. Horſes, cows, ſheep, and goats, refuſe to eat it.

BALLOTADE, in the menage, the leap of a horſe between two pillars, or upon a ſtraight line, made with juſtneſs of time, with the aid of the hand and the calves of the legs: and in ſuch a manner, that when his fore-feet are in the air, he ſhows nothing but the ſhoes of his hinder-feet without yerking out.

BALLOTING, a method of voting at elections, &c. by means of little balls uſually of different colours, by the French called *ballots*; which are put into a box privately.

BALLS, or BALLETS, in heraldry, a frequent bearing in coats of arms, uſually denominated, according to their colours, bezants, plates, hurts, &c.

Balluſter || Balſam.

BALLUSTER, a ſmall kind of pillar uſed for balluſtrades.

BALLUSTRADE, a ſeries or row of balluſters, joined by a rail; ſerving as well for a reſt to the elbows as for a fence or incloſure to balconies, altars, ſtaircaſes, &c. See ARCHITECTURE, n° 74.

BALM, in botany. See MELISSA.

BALM, or BALSAM. See BALSAM.

Balm of Gilead. See AMYRIS.

BALNAVES (Henry), a Scottiſh proteſtant divine, born in the ſhire of Fife, in the reign of James V. and educated at the univerſity of St Andrew's. He went afterwards to France in order to finiſh his ſtudies; and returning to Scotland, was admitted into the family of the earl of Arran, who at that time governed the kingdom: but in the year 1542 the earl diſmiſſed him for having embraced the Proteſtant religion. In 1564, he joined, ſays Mackenzie, the murderers of cardinal Beaton; for which he was declared a traitor, and excommunicated. Whilſt that party were beſieged in the caſtle of St Andrew's, they ſent Balnaves to England, who returned with a conſiderable ſupply of proviſions and money; but being at laſt obliged to ſurrender to the French, he was ſent with the reſt of the garriſon to France. He returned to Scotland about the year 1559; and having joined the congregation, he was appointed one of the commiſſioners to treat with the duke of Norfolk on the part of queen Elizabeth. In 1563 he was made one of the lords of ſeſſion, and appointed by the general aſſembly, with other learned men, to reviſe the Book of Diſcipline. Knox, his cotemporary, and fellow-labourer, gives him the character of a very learned and pious divine. He died at Edinburgh in the year 1579. He wrote, 1. *A Treatiſe concerning Juſtification*. Edinb. 1550. 8vo. 2. *A Catechiſm, or Confeſſion of Faith*. Edinb. 1584, 8vo.

BALNEARII SERVI, in antiquity, ſervants or attendants belonging to the baths. Some were appointed to heat them, called *fornicatores*; others were denominated *capſarii*, who kept the cloaths of thoſe that went into them; others *aliptæ*, whoſe care it was to pull off the hair; others *unctuarii*, who anointed and perfumed the body.

BALNEARIUS FUR, in antiquity, a kind of thief who practiſed ſtealing the cloaths of perſons in the baths; ſometimes alſo called *fur balnearum*. The crime of thoſe thieves was a kind of ſacrilege; for the hot baths were ſacred: hence they were more ſeverely puniſhed than common thieves who ſtole out of private houſes. The latter were acquitted with paying double the value of the thing ſtolen; whereas the former were puniſhed with death.

BALNEUM, a term uſed by the chemiſts to ſignify a veſſel filled with ſome matter, as ſand, water, or the like, in which another is placed that requires a more gentle heat than the naked fire. See CHEMISTRY, n° 79.

BALSA, an ancient town of Luſitania in the Ager, Cunæus; now *Tavira*, capital of Algarva.

BALSAM, or NATIVE BALSAM, an oily, reſinous, liquid ſubſtance, flowing either ſpontaneouſly, or by means of inciſion, from certain plants. There are a great variety of balſams, generally denominated from the

Balſamics | Baltimore.

the ſubſtances from which they are obtained; and which are explained under their names as they occur.

BALSAMICS. *Balſamica* is a Latin word which ſignifies *mitigating*. The term *balſamic* is a very lax one; it includes medicines of very different qualities, as emollients, detergents, reſtoratives, &c. but in medicines of all theſe kinds there ſeems to be this requiſite in them, *viz.* that they be ſoft, yielding, and adheſive, alſo that by their ſmallneſs they have a ready diſpoſition to motion. Medicines of this tribe are generally required for complaints whoſe ſeat is in the viſcera; and as they cannot be conveyed there but by the common road of the circulation, it follows, that no great effects can be expected from them but by their long continuation. Hoffman calls by the name of *balſamics* thoſe medicines which are hot and acrid, alſo the natural balſams, gums, &c. by which the vital heat is increaſed.

Motherby's Med. Dict.

BALSORA. See BASSORA.

BALTAGI, among the Turks, porters, and hewers of wood, in the court of the grand ſignior; who alſo mount on horſeback when the emperor rides out. Part of them alſo, who, for that purpoſe, muſt be caſtrated, keep watch at the gates of the firſt and ſecond courts of the ſeraglio. Theſe laſt are called *capigi*, and their commander *capigi paſcha*.

BALTIC SEA, a great gulph ſurrounded by Sweden, Ruſſia, Courland, Pruſſia, Pomerania, and Denmark. The king of Denmark levies a tax at Elſineur on every ſhip that enters the Baltic ſea. It is remarkable that this ſea never ebbs nor flows, and there is always a current ſets through the ſound into the ocean. It is generally frozen over three or four months in the year. Yellow amber is found in plenty on this coaſt.

BALTIMORA, in botany: a genus of the polygamia neceſſaria order, belonging to the ſyngeneſia claſs of plants. The receptaculum is chaffy; there is no pappus; the calyx is cylindrical and polyphyllous; and the ray of the corolla is quinqueflorous. There is but one ſpecies, the recta, a native of Maryland.

BALTIMORE, a large and flouriſhing town of Maryland, in North America, ſituated on the north ſide of Patapſco river around the baſon, in which the water riſes to the depth of about ſix feet in common tides, but at Fell's Point the water is deep enough for ſhips of burden to come up. The trade and conſequent improvement of Baltimore has been more rapid than that of any town in the United States: the principal trade of Maryland centers here, and its exports to Europe and the Weſt Indies are extenſive. The ſtreets are well built and handſome: and the inhabitants are hoſpitable to ſtrangers, and maintain a friendly ſocial intercourſe with one another. The town ſtands low and was formerly unhealthy, which the great increaſe of buildings and improvements, particularly the paving of the ſtreets have contributed to remedy. Its ſituation is favourable for defence againſt a naval force, as the entrance to the harbour, about a mile below Fell's Point, is not more than a piſtol ſhot acroſs. W. Long. 76. 30. N. Lat. 39. 21.

BALTIMORE, a town of Ireland in the county of Corke, and province of Munſter, with the title of a barony. It is ſeated on a headland which runs into the ſea, five miles north-eaſt of Cape Clear. W. Long. 9. 10. N. Lat. 51. 15.

BALTIMORE-Bird. See ORIOLUS.

Baluclavo | Balzac.

BALUCLAVO, or JAMBOL, a ſea-port town of Crimea on the Black Sea, where they build ſhips for the Grand Signior. E. Long. 35. 15. N. Lat. 44. 50.

BALUZE (Stephen), a French writer, born in 1651, and ſometime librarian to M. Colbert. In 1693 he obtained a penſion, with the poſt of director of the royal college, for writing the lives of the popes of Avignon; both which advantages he ſoon loſt in the fluctuation of court parties. M. Baluze is much more noted for collecting ancient MSS. and illuſtrating them by notes, than famed for his own compoſitions.

BALYUR, or BALIUR, a ſea-port of Africa in the kingdom of Dancali, about 14 hours journey weſt from Babel-Mandel. It is remarkable only for being the landing place of the Abyſſinian Patriarch Alphonſus Mendez, with his Jeſuits and Portugueſe, on April 3d, 1724. The king, who had received orders from the Abyſſinian emperor to give them a proper reception, diſpatched his ſon to meet them and conduct them to him. The royal palace they found to conſiſt of about half a dozen of tents, and a ſcore of huts, fenced about with a thorn hedge, and ſhaded by ſome wild kinds of trees. Near the palace was a river, which was then quite dried up, and no water to be found but what was digged for in the channel. The hall of audience was only a large tent about a muſket-ſhot from the reſt. At the upper end was a kind of throne made of ſtones and clay, covered with a carpet, and two velvet cuſhions. At the other end was his majeſty's horſe with the ſaddle and other accoutrements hanging on one ſide; it being the cuſtom of this country for the maſter and horſe to lie together, whether king or ſubject. Around the hall were about 50 young men ſitting croſs-legged; and when the Portugueſe ambaſſadors were admitted, they were made to ſit down in the ſame poſture. Soon after came the king preceded by ſome of his domeſtics, one having an earthen pitcher full of hydromel, another a cup made of porcelane, a third carrying a cocoa ſhell full of tobacco, and a fourth bringing a ſilver tobacco-pipe with ſome fire. Next to them was the king, dreſſed in a light ſilk ſtuff, having on his head a turban, from the rims of which hung a parcel of rings nicely wrought, which dangled before his face. He had in his hand a ſhort kind of javelin, and was followed by all the chief officers of his court and houſehold. The reſpect paid him at his coming in was by ſtanding on their feet, and ſquatting down again twice, after which they went forward to kiſs his hand.

BALZAC (John Lewis Guez de), born at Angouleme in 1595. Voltaire allows him the merit of having given numbers and harmony to the French proſe, but cenſures his ſtyle as ſomewhat bombaſt. The critics of his own time gave him no little diſquiet; and he gave them no little advantage over him by his ſallies of vanity, and ſome particular propoſitions which were a little dangerous. Mr Balzac, getting rid of theſe diſputes by his moderation, ſettled at his country ſeat; refined his ſtyle and genius; and got by his letters and other writings which he publiſhed from time to time, the reputation of being the firſt writer in France. He was at length drawn from his retirement by the hopes of making his fortune under cardinal Richlieu,

Bamba | Bamboccio

who had formerly courted his friendſhip; but in a few years he retired again, diſguſted with the ſlaviſh dependence of a court life. All he obtained from the court was a penſion of 2000 livres, with the titles of councellor of ſtate and hiſtoriographer of France. He died in 1654; and was buried in the hoſpital of Notre Dame des Anges, to which he bequeathed 12,000 livres. He left an eſtate of 100 franks *per ann.* for a gold medal to be beſtowed every two years for the beſt diſcourſe on ſome moral ſubject.—Beſides his letters, he wrote a work called *Oeuvres Diverſes*, i. e. on various ſubjects; The Prince; The Chriſtian Socrates, &c. and many other pieces; all of which have been publiſhed in two volumes folio.

BAMBA, a province of the kingdom of Congo in Africa.—It is ſituated between the rivers of Ambriſi and Loſe; the laſt of which parts it from Pemba on the eaſt, as the Ambriſi does from the province of Sogno on the north. Along the ſea-coaſts it extends itſelf northward to the river Lelunda; and on the ſouth to that of Danda, which parts it from the kingdom of Angola. The governors of this province bear the title of *dukes*, and are always ſome of the princes of the royal family. They are as deſpotic and arbitrary as if they were really kings, notwithſtanding the care and pains their monarchs have taken to keep them within due bounds. The ſoil of this province is very fertile; and would produce all the neceſſaries of life in great plenty, were the inhabitants but induſtrous in its cultivation. The ſea-coaſts produce a vaſt quantity of ſalt, which could be purified with little trouble, and would yield an extraordinary revenue if the duties were duly paid; but theſe the governors find means to ſink moſtly into their own coffers.—Here is alſo the fiſhery of the zimbis, or little ſea-ſnail, whoſe ſhell is the current coin not only in this and the neighbouring kingdom, but alſo in the moſt diſtant parts of Africa. Here are alſo ſaid to be mines of gold, ſilver, quickſilver, copper, tin, and iron; but none except the iron mines are allowed to be worked.

BAMBERG, a large handſome town of Franconia in Germany, and capital of a biſhopric of the ſame name. It was formerly imperial, but is now ſubject to the biſhop. The country about it produces plenty of corn, fruits, and liquorice. It has an univerſity, founded in 1585; and is ſituated at the confluence of the rivers Main and Reidnitz. E. Long. 10. 15. N. Lat. 50. 10.

Bamberg, a town of Bohemia, ſituated at the foot of a mountain. E. Long. 16. 50. N. Lat. 49. 53.

BAMBOCCIO, a celebrated painter of converſations, landſcapes, cattle, &c. was born at Laeren, near Narden, in 1613. His name was Peter Van Laer; but in Italy they gave him the name of Bamboccio, on account of the uncommon ſhape of his body, the lower part being one third part longer than the upper, and his neck ſo ſhort that it was buried between his ſhoulders. He had, however, an ample amends for the unſeemlineſs of his limbs, in the ſuperior beauties of his mind: he was endowed with an extenſive genius; and, indeed, had an univerſal taſte for every part of painting. He reſided at Rome for ſixteen years ſucceſſively; every day ſtudying to improve himſelf by thoſe beautiful models which were continually open to his obſervation, and by the lovely ſcenery in the environs of that city. He was held in the higheſt eſteem by all ranks of men, as well as by thoſe of his own profeſſion; not only on account of his extraordinary abilities, but alſo for the amiable qualities of his mind. He ſtudied nature inceſſantly; obſerving with a curious exactneſs every effect of light on different objects, at different hours of the day; and whatſoever incident afforded pleaſure to his imagination, his memory for ever perfectly retained. His ſtile of painting is ſweet and true; and his touch delicate, with great tranſparency of colouring. His figures are always of a ſmall ſize, well proportioned, and correctly deſigned; and altho' his ſubjects are taken but from the lower kind of nature, ſuch as plunderings, playing at bowls, inns, farrier ſhops, cattle, or converſations; yet whatever he painted was ſo excellently deſigned, ſo happily executed, and ſo highly finiſhed, that his manner was adopted by many of the Italian painters of his time. His works are ſtill univerſally admired, and he is juſtly ranked among the firſt claſs of the eminent maſters. His hand was as quick as his imagination, ſo that he rarely made ſketches or deſigns for any of his works; he only marked the ſubject with a crayon on the canvas, and finiſhed it without more delay. His memory was amazing: for whatever objects he ſaw, if he conſidered them with any intention to inſert them in his compoſitions, the idea of them was ſo ſtrongly impreſſed on his mind, that he could repreſent them with as much truth as if they were placed before his eyes. Sandrart obſerves, that although painters who are accuſtomed to a ſmall ſize are frequently inaccurate in the diſpoſition of the different parts of their ſubject, ſeeming content if the whole appears natural; yet Bamboccio was as minutely exact in having his figures, trees, grounds, and diſtances, determined with the utmoſt preciſion and perſpective truth, as the beſt maſters uſually are in pictures of the largeſt ſize; which is one circumſtance that cauſes the eye to be ſo agreeably deluded by the paintings of Bamboccio. In the latter part of his life, he was ſeverely tormented with an aſthmatic complaint, which he endured with much impatience; and it is reported, that as the diſorder ſeemed to him unſupportable, he threw himſelf into a canal to ſhorten his miſery, and was drowned. His death happened in 1673.

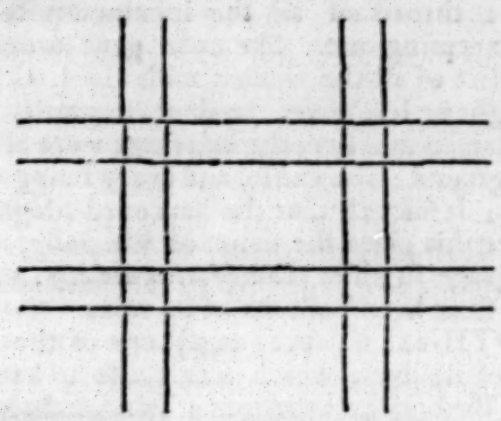
Bamboe.

BAMBOE, in botany, the trivial name of a ſpecies of arundo. See Arundo.

Bamboe-Habit; a Chineſe contrivance by which a perſon who does not know how to ſwim may eaſily keep himſelf above water. The following account of it is from a letter to the author of the *Seaman's Preſervative*. "In the year 1730, I was paſſenger in a ſhip from Batavia to China, burden about 400 tons, called the *Pridae*, Franciſco Xavier commander, freighted by Engliſh, Chineſe, and Portugueſe. Near the coaſt of China we met one of thoſe ſtorms called a *Tuſtoon (Tau fong)*, or a great wind, which carried away all our maſts, bowſprit, and rudder; and in our hold we had ſix feet of water, expecting every moment the ſhip would founder.—We conſequently were conſulting our preſervation: the Engliſh and Portugueſe ſtood in their ſhirts only, ready to be thrown off; but the Chineſe merchants came upon deck, not in a cork-jacket, but I will call it a *bamboe-habit*, which had lain ready in their cheſts againſt ſuch dangers; and it was thus conſtructed; four bamboes, two before and

Bamborough Bambuck

and two behind their bodies, were placed horizontally, and projected about 28 inches. These were croſſed on each ſide by two others, and the whole properly ſecured, leaving a ſpace for their body; ſo that they had only to put it over their heads, and tie the ſame ſecurely, which was done in two minutes, and we were ſatisfied they could not poſſibly ſink." The ſhape is here ſubjoined.



BAMBOROUGH. See *Holy-Iſland*.

BAMBUCK, a country of Africa, of which the following account is given by the Abbe Raynal, on the credit of a modern traveller whom he does not name. "In the interior part of Africa, under the 12th or 13th degree of north latitude, there is (ſays a modern traveller) a pretty large country, known by the name of *Bambuck*. It is not ſubject to a particular king; but governed by village lords, called *farims*. Theſe hereditary and independent chiefs are all obliged to unite for the defence of the ſtate, when it is either attacked as a community, or only in one of its branches.

"The territory of this ariſtocratical ſtate is dry and barren. It produces neither maize, rice, nor pulſe. The inſupportable heat it is ſubject to, proceeds in part from its being ſurrounded by high mountains, which prevent the wind from refreſhing the air. The climate is as unwholeſome as it is diſagreeable: vapours, which continually iſſue from the bowels of a ſoil replete with minerals, render this country unfit to live in, eſpecially to ſtrangers.

"It is gold that hath made this miſerable country an object worthy of notice: gold, which in the eyes of the covetous man ſeems to compenſate for all the evils of nature, tho' in reality it increaſes them all. This metal is ſo common in this country, that it is found almoſt indiſcriminately every where. To obtain it, ſometimes it is ſufficient to ſcrape the ſurface of the earth, which is clayiſh, light, and mixed with ſand. When the mine is very rich, it is digged only to the depth of a few feet, and never deeper; though it has been obſerved, that the lower it was digged, the more gold the ſoil afforded. The miners are too indolent to purſue a toil which conſtantly becomes more tedious, and too ignorant to perceive the inconveniences it would be attended with. Their negligence and their folly are in this inſtance ſo extraordinary, that in waſhing the gold, in order to ſeparate it from the earth, they only preſerve the larger pieces: the light parts paſs away with the water, which flows down an inclined plain.

"The inhabitants of Bambuck do not work theſe mines at all times, nor are they at liberty to do it when they pleaſe. They are obliged to wait till private or public wants determine the farims to grant this permiſſion. When it is proclaimed, all who are able to avail themſelves of this advantage meet at the appointed place. When their work is finiſhed, a diviſion is made. Half of the gold goes to the lord, and the remainder is equally diſtributed among the labourers. Thoſe who want gold at any other time than that of the general digging, ſearch for it in the beds of the rivers, where it is very common.

"The French and Engliſh have ſucceſſively been deſirous of appropriating to themſelves theſe real or imaginary riches. Some thought they could reach this country by the Niger, others by the Salum. Far from having ſucceeded in their attempts of becoming maſters of this country, they have not yet aſcertained its exiſtence. The unſucceſsfulneſs of paſt efforts hath redoubled the activity of ſanguine minds; ſenſible and judicious merchants have choſen to limit themſelves to a commerce much more important, which is that of ſlaves."

Bamff.

BAMFF, a ſhire of Scotland, comprehending part of Buchan, with the countries of Strathdovern, Boyn, Enzie, Strathaven, and Balvenie, extends 32 miles from eaſt to weſt, and 13 in breadth from north to ſouth. On the ſouth, it is ſeparated from part of Buchan by the river Ugie; on the eaſt it is watered by the Dovern and the German Ocean; on the weſt it is bounded by the Spey and the county of Murray; on the ſouth-weſt, it borders on Badenoch and the Braes of Mar; and on the north, it is confined by the Murray Frith. The face of the country is agreeably diverſified with hill and dale, not without woods, well watered with rivers, and exhibiting many ſeats and plantations. The air is pure and keen, the climate healthy, and the ſoil fertile, producing plentiful crops of corn. The country of Buchan, extending northwards from the river Ugie to the ſea, and weſtward as far as Devron, comprehending a tract of 20 miles in length and nine in breadth, is more free from hills and mountains than any other county of the ſame extent in the kingdom of Scotland. It is inhabited chiefly by Lowlanders, and gives the title of *earl* to the family of Erſkine; of which family, however, Erſkine of Mar is the chief. The county of Bamff abounds with the neceſſaries and comforts of life. The paſture-grounds yield ſheep, cattle, and horſes: the arable lands produce plenty of corn; while the rivers and ſea ſupply great quantities of fiſh. Various minerals have been found in different parts of the ſhire; and a piece of amber, as large as a horſe, was once caſt aſhore on the beach. In the mountainous diſtrict of Balvenie, on the weſtern ſide of the ſhire; watered by the Spey, there is a noted rock, which produces hones and whetſtones ſufficient to ſupply the whole iſland. Here are alſo veins of alum ſtone, and ſprings of alum water. Strathallan, another diſtrict to the north-eaſt of Balvenie, abounds with ſuch plenty of lime-ſtone, that the inhabitants uſe it as common ſtone in building their houſes; and moreover burn a great quantity of it into lime, which they ſell to good advantage in the village of Keith, on the river Dovern. Along this whole coaſt, there are ancient Daniſh monuments, ſuch as cairns, tumuli, and huge ſtones ſtanding erect. In Strathaven, a hilly country, lying along the limpid river

Bamff
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Bamiyan.

river Avin, which falls into the Spey, we meet with Gordon Caſtle, belonging to the Duke of Gordon, the moſt princely edifice in the north of Scotland, conſiſting of noble apartments magnificently furniſhed, and environed with fine gardens and parks well ſtored with fallow-deer. The ſame nobleman poſſeſſes ſeveral other ſeats in this county.

BAMFF, the capital of the ſhire of that name in Scotland, is pleaſantly ſituated on the ſide of a hill, at the mouth of the river Devron. It has ſeveral ſtreets; of which that with the town-houſe in it, adorned with a new ſpire, is very handſome. This place was erected into a borough by virtue of a charter from Robert II. dated October 7. 1372, endowing it with the ſame privileges, and putting it on the ſame footing, with the burgh of Aberdeen; but tradition ſays it was founded in the reign of Malcolm Canmore. It gives title of *baron* to a branch of the Ogilvie family. The harbour is very bad, as the entrance at the mouth of the Devron is very uncertain, being often ſtopped by the ſhifting of the ſands, which are continually changing in great ſtorms; the pier is therefore placed on the outſide. Much ſalmon is exported from hence. About Troop-head ſome kelp is made; and the adventurers pay the lord of the manor 50 l. *per annum* for the liberty of collecting the materials. Near the town is a moſt magnificent ſeat lately built by the Earl of Fife. It lies in a beautiful plain waſhed by the Devron, the lofty banks of which clothed with wood on the oppoſite ſide, afford a delightful contraſt to the ſoft vale beneath. W Long. 2. 5. N. Lat. 57. 40.

BAMIER, the name of a plant common in Egypt. It produces a pyramidal huſk, with ſeveral compartments, of the colour of a lemon, and filled with muſky ſeeds. This huſk dreſſed with meat is a wholeſome food, and has a very agreeable flavour. The Egyptians make great uſe of it in their ragouts.

BAMIYAN, a city of Aſia, ſituated in the province of Zableſtan, 10 days journey from Balkh, and eight from Gazna. It is remarkable only for its dreadful cataſtrophe when taken by Jenghiz Khan in 1221. At that time the city belonged to Sultan Jalallodin, the laſt of the famous Mahmud Gazni's race. Jenghiz Khan was at that time about to attack Gazna, that prince's capital; but was ſtopped by the garriſon of Gazna, which he had hoped would give him no trouble. In this, however, he was diſappointed. The people had for a long time expected an attack; and had therefore ruined the country for five or ſix leagues round, while the peaſants had carried away the ſtones, and every thing that could be of uſe to the beſiegers. Accordingly, Jenghiz Khan having erected wooden towers, and planted his engines upon them, was in a ſhort time obliged to give over his attacks till millſtones and other materials could be brought from a great diſtance. The walls of the city were very ſtrong, ſo that the engines of the Moguls made but little impreſſion; and the garriſon making frequent and furious ſallies cut off whole ſquadrons of their enemies, and frequently overthrew their towers and engines. This exceedingly chagrined Jenghiz Khan; who one day returning from a fruitleſs attack, and hearing of the defeat of one of his generals by Jalallodin, ſwore to be revenged on Bamiyan. This fury coſt the life of one of his grandchildren; who expoſing himſelf too much, to pleaſe his grandfather, was ſlain with an arrow.—At laſt, however, by the numberleſs multitude of the Moguls, who continued the attacks without intermiſſion, the city was taken, after its walls had been ruined in many places, and the braveſt ſoldiers and officers of the garriſon ſlain in its defence. The mother of the young prince who had been killed entering with the troops, and more deſerving the name of a fiend than a woman, cauſed the throats of all the inhabitants to be cut, without excepting one. She even gave orders to rip up the bellies of all the women with child, that not an infant might be left alive. In ſhort, to gratify the rage of this inhuman monſter, the buildings were all levelled with the ground; the cattle, and every living creature, deſtroyed; inſomuch that the hardened Moguls themſelves gave this place the name of *Maubalig*, which in their language ſignifies *the unfortunate city*. A ſtrong caſtle has ſince been built out of its ruins.

Bamoth-Baal.
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Bancs.

BAMOTH-BALL (anc. geog.), one of the towns of the tribe of Reuben, which ſeems alſo to have had a temple of Baal on an eminence; lying eaſtwards, and not far from the river Arnon, and the territory of Moab. Jerome calls it *Bamoth*, a city of the Amorites, beyond Jordan, in the poſſeſſion of the ſons of Reuben. Whether the ſame with that mentioned Numb. xxi. is doubtful, from the diſagreement of interpreters; and yet we may admit it to be the place of encampment of the Iſraelites, and of Balaam's firſt ſtation, or where he had the firſt view of the rear of the people.

BAMPTON, a town of Devonſhire, ſituated in a bottom ſurrounded with high hills. W. Long. 4. 25. N. Lat. 51. 5.

BAN, or BANS. See BANN.

BAN, in commerce, a ſort of ſmooth fine muſlin, which the Engliſh import from the Eaſt Indies. The piece is almoſt a yard broad, and runs about 20 yards and a half.

BANANA-TREE, a ſpecies of the muſa or plantain. See MUSA.

BANARES, or BENARES, a handſome town of Aſia, in the dominions of the Great Mogul, greatly celebrated for its ſanctity, and being the univerſity of the Indian Bramins. See OBSERVATORY. It is ſeated on the north ſide of the river Ganges, in E. Long. 82. 30. N. Lat. 26. 20.

BANBURY, a town of Oxfordſhire in England, ſituated on the river Charwell, in W. Long. 1. 20. N. Lat. 52. 0.

BANC, or BENCA, in law, denotes a tribunal, or judgment-ſeat: hence *king's banc* is the ſame with the *court of king's bench*, and *common banc* with that of *common pleas*.

BANCI JUS, or the privilege of having a bench, was anciently only allowed to the king's judges, *qui ſummam adminiſtrant juſtitiam*. Inferior courts, as courts-baron, hundred-courts, &c. were not allowed that prerogative: and even at this day the hundred-court at Freibridge in Norfolk is held under an oak at Gey-wood; and that of Woolfry, in Herefordſhire, under an oak near Aſhton in that county, called *Hundred-oak*.

BANCA, an iſland of Aſia, in the Eaſt Indies, between Sumatra and Borneo; from the firſt of which it is ſeparated only by a narrow channel. E. Long. 105. 10. N. Lat. 13. 25.

BANCALIS,

Bancalis ‖ Banda.

BANCALIS, a ſea-port town on the eaſt coaſt of the iſland of Sumatra, where the Dutch have a ſettlement. E. Long. 99. 7. N. Lat. 1. 5.

BANCK (Peter Vander), an engraver of conſiderable repute, was born at Paris, and received his inſtructions in the art from the celebrated Francois de Poilly. He came over into England with Gaſcar the painter about the year 1674; and married the ſiſter of a gentleman of eſtate in Hertfordſhire, named Foreſter. He was a laborious artiſt: but the pay he received for his plates being by no means adequate to the time he beſtowed upon them, he was reduced to want; and, retiring from buſineſs, ſought an aſylum in the houſe of his brother-in-law. He died in Bradfield, and was buried in the church there, in 1674; leaving his widow in poſſeſſion of the chief part of his plates, which ſhe diſpoſed of to Brown, a print-ſeller, to great advantage, and left an eaſy fortune.—His chief employment was engraving of portraits; and, according to Virtue's account of this artiſt publiſhed by the Hon. Mr Walpole, he was the firſt in England who engraved them on ſo large a ſcale. But even the novelty, it ſeems, added to their merit, could not ſufficiently recommend them to ſupport the artiſt. Like many of Poilly's diſciples, his great merit, according to Mr. Strutt, conſiſts in the laboured neatneſs and management of the mechanical part of the art. Freedom, harmony, and chaſteneſs of outline, are by no means the characteriſtic of his prints. However, tho' they cannot rank with the ſuperior productions of Edelink or Nantueil, &c. they have their ſhare of merit; and doubtleſs will be always eſteemed in England as preſerving the beſt reſemblance of many eminent perſons who were living at that time.

BANCO, an Italian word which ſignifies *bank*. It is commonly uſed to ſignify the Bank of Venice.

BANCOCK, a town of the kingdom of Siam in Aſia, with a fort, which was once in the poſſeſſion of the French, but they were driven from it in 1688. E. Long. 101. 5. N. Lat. 13. 25.

BAND, in a general ſenſe, ſome ſmall narrow ligament, wherewith any thing is bound, tied, or faſtened.

BAND, in architecture, a general name for any flat low member, or moulding, that is broad but not very deep.

BAND of Soldiers, in military affairs, thoſe who fight under the ſame flag or enſign.

BAND of Penſioners, a company of 120 gentlemen, who receive a yearly allowance of 100l. for attending on his majeſty on ſolemn occaſions.

BAND is alſo the denomination of a military order in Spain, inſtituted by Alphonſus XI. king of Caſtile, for the younger ſons of the nobility; who, before their admiſſion, muſt ſerve 10 years at leaſt, either in the army or at court; and are bound to take up arms for the catholic faith againſt the infidels.

BAND, in ſurgery. See BANDAGE.

BANDA ISLANDS, the general name of five iſlands in the Eaſt-Indies, belonging to the Dutch. Two of them are uncultivated, and almoſt entirely uninhabited; the other three claim the diſtinction of being the only iſlands in the world that produce the nutmeg.

If we except this valuable ſpice, the iſlands of Banda, like all the Moluccas, are barren to a dreadful degree. What they produce in ſuperfluities they want in neceſſaries. The land will not bring forth any kind of corn; and the pith of the ſago ſerves the natives of the country inſtead of bread. Banda ‖ Banditti.

As this food is not ſufficient for the Europeans who ſettle in the Moluccas, they are allowed to fetch proviſions from Java, Maſſacar, or the extremely fertile iſland of Bali. The company itſelf carries ſome merchandiſe to Banda.

This is the only ſettlement in the Eaſt-Indies that can be conſidered as an European colony; becauſe it is the only one where the Europeans are proprietors of lands. The company finding that the inhabitants of Banda were ſavage, cruel, and treacherous, becauſe they were impatient under their yoke, reſolved to exterminate them. Their poſſeſſions were divided among the white people, who got ſlaves from ſome of the neighbouring iſlands to cultivate the lands. Theſe white people are for the moſt part Creoles, or malecontents who have quitted the ſervice of the company. In the ſmall iſland of Roſinging, there are likewiſe ſeveral banditti, whom the laws have branded with diſgrace; and young men of abandoned principles, whoſe families wanted to get rid of them: ſo that Banda is called the *iſland of correction*. The climate is ſo unhealty, that theſe unhappy men live but a ſhort time. It is on account of the loſs of ſo great a number of hands, that attempts have been made to transfer the culture of the nutmeg to Amboyna; and the company were likewiſe probably influenced by two other ſtrong motives of intereſt, as their trade could be carried on with leſs expence and greater ſafety. But the experiments that have been made have proved unſucceſsful, and matters remain in their former ſtate.

BANDAGE, in ſurgery, a fillet, roller, or ſwath, uſed in dreſſing and binding up wounds, reſtraining dangerous hemorrhagies, and in joining fractured and diſlocated bones.

BANDALEER, or BANDELEER, in military affairs, a large leathern belt, thrown over the right ſhoulder, and hanging under the left arm; worn by the ancient muſqueteers, both for the ſuſtaining of their fire-arms, and for the carriage of their muſket-charges, which being put up in little wooden caſes, coated with leather, were hung, to the number of twelve, to each bandaleer.

BANDELET, or BANDLET, in architecture, any little band, or flat moulding, as that which crowns the Doric architrave.

BANDER-CONGO, a ſmall ſea-port town in Aſia, ſeated on the Perſian Gulph. E. Long. 54. 10. N. Lat. 19. 0.

BANDERET, a general, or one of the commanders in chief of the forces.—This appellation is given to the principal commanders of the troops of the canton of Bern in Switzerland, where there are four banderets, who command all the forces of that canton.

BANDEROLL, a little flag, in form of a guidon, extended more in length than in breadth, uſed to be hung out on the maſts of veſſels, &c.

BANDITTI, from the Italian *bandito*; perſons proſcribed, or, as we call it, outlawed: ſometimes denominated *banniti* or *forris banniti*. It is alſo a denomination given to highwaymen or robbers who infeſt the roads in troops, eſpecially in Italy, France,

Banditti
‖
Bandy-legs

and Sicily. Mr Brydone, in his Tour through Sicily, informs us, that in the eaſtern part, called *Val Demoni* from the devils that are ſuppoſed to inhabit Mount Ætna, it has ever been found altogether impracticable to extirpate the banditti; there being numberleſs caverns and ſubterraneous paſſages round that mountain, where no troops could poſſibly purſue them; beſides, they are known to be perfectly determined and reſolute, never failing to take a dreadful revenge on all who have offended them. Hence the prince of Villa Franca has embraced it, not only as the ſafeſt, but likewiſe as the wiſeſt and moſt political ſcheme, to become their declared patron and protector: and ſuch of them as think proper to leave their mountains and foreſts, though perhaps only for a time, are ſure to meet with good encouragement and a certain protection in his ſervice, where they enjoy the moſt unbounded confidence, which, in no inſtance, they have ever yet been found to make an improper or a diſhoneſt uſe of. They are clothed in the prince's livery, yellow and green, with ſilver lace; and wear likewiſe a badge of their honourable order, which intitles them to univerſal fear and reſpect from the people.

In ſome circumſtances, theſe banditti are the moſt reſpectable people of the iſland, and have by much the higheſt and moſt romantic notions of what they call their point of honour. However criminal they may be with regard to ſociety in general; yet, with reſpect to one another, and to every perſon to whom they have once profeſſed it, they have ever maintained the moſt unſhaken fidelity. The magiſtrates have often been obliged to protect them, and pay them in court, as they are known to be perfectly determined and deſperate, and ſo extremely vindictive that they will certainly put any perſon to death that has ever given them juſt cauſe of provocation. On the other hand, it never was known that any perſon who had put himſelf under their protection, and ſhowed that he had confidence in them, had cauſe to repent of it, or was injured by any of them in the moſt minute trifle; but, on the contrary, they will protect him from impoſitions of every kind, and ſcorn to go halves with the landlord, like moſt other conductors and travelling ſervants, and will defend him with their lives if there is occaſion. Thoſe of their number who have thus enliſted themſelves in the ſervice of ſociety, are known and reſpected by the other banditti all over the iſland; and the perſons of thoſe they accompany are ever held ſacred. For theſe reaſons, moſt travellers chooſe to hire a couple of them from town to town; and may thus travel over the whole iſland in ſafety.

BANDORA, the capital of the iſland of Salſet, on the weſt coaſt of the peninſula on this ſide the Ganges. It is ſeparated from the iſland of Bombay by a narrow channel, and ſubject to the Portugueſe. E. Lon. 72. 30. N. Lat. 19. 0.

BANDORE, the name of a muſical inſtrument with ſtrings, reſembling a lute, and ſaid to be invented in the fourth year of Queen Elizabeth, by John Roſe, a citizen of London.

BANDY-LEGS, from the French *bander*, 'to bend,' a diſtortion of the legs, when they turn either inward or outward on either ſide; ariſing from ſome defect in the birth or imprudence in the nurſe, endeavouring to make a child ſtand or walk before his legs were ſtrong enough to ſuſtain the weight of his body. See VALGUS.

Bane
‖
Banguc.

BANE (from the Sax. *bana*, a murderer), ſignifies deſtruction or overthrow. Thus, "I will be the *bane* of ſuch a man," is a common ſaying. So, when a perſon receives a mortal injury by any thing, we ſay, "it was his *bane*:" and he who is the cauſe of another man's death, is ſaid to be *le bane*, i. e. a malefactor.

BANFF. See BAMFF.

BANGHIR, a town of Ireland, in king's county in the province of Leinſter, ſeated on the river Shannon. W. Long. 8. 5. N. Lat. 53. 10.

BANGLE EARS, an imperfection in a horſe, remedied in the following manner. Place his ears in ſuch a manner as you would have them ſtand; bind them with two little boards ſo faſt that they cannot ſtir, and then clip away all the empty wrinkled ſkin cloſe by the head.

BANGIUS (Thomas), a Daniſh divine, and an elegant Latin writer on the origin of languages and a variety of other ſubjects. He died in 1661.

BANGOR, an epiſcopal city of Carnarvonſhire in North Wales. In ancient times it was ſo conſiderable, that it was called *Bangor the Great*, and defended by a ſtrong caſtle: but it is now a very mean place; the principal buildings being the cathedral, the biſhop's palace, and a free ſchool. The ſee is of very great antiquity, and its founder unknown. The church is dedicated to St. Daniel, who was biſhop here about the year 516; but for near 500 years afterwards, there is no certainty of the names of his ſucceſſors. Owen Glendower greatly defaced the cathedral church; but Biſhop Dean repaired it again. This ſee met a ſtill more cruel ravager than Owen Glendower, in the perſon of Biſhop Bulkeley; who not only alienated many of the lands belonging to it, but even ſold the bells of the church. This dioceſe contains the whole of Carnarvonſhire except three pariſhes, the ſhire of Angleſey, and part of the ſhires of Denbigh, Merioneth, and Montgomery, in which are 107 pariſhes, whereof 36 impropriated. It has three archdeaconries, viz. Bangor, Angleſey, and Merioneth; of which the two firſt are commonly annexed to the biſhopric for its better ſupport. This ſee is valued in the king's books at L. 131 : 16 : 4, and is computed to be worth annually L. 1200. The tenths of the clergy are L. 151 : 14 : 3½. To the cathedral there belong a biſhop, a dean, an archdeacon, a treaſurer, and two prebendaries, endowed; a precentor, a chancellor, and three canons, not endowed; three vicars coral, an organiſt, lay-clerks, choriſters, and two officers. W. Long. 4. 10. N. Lat. 53. 20.

BANGOR, a town of Ireland, in the county of Down and province of Ulſter. It is ſeated on the ſouth ſhore of the bay of Carrick Fergus, oppoſite to the town of that name; and ſends two members to parliament. W. Long. 6. N. Lat. 54. 42.

BANGUE, a ſpecies of opiate, in great uſe throughout the eaſt, for drowning cares and inſpiring joy.—This by the Perſians is called *beng*; by the Arabs, *eſſrar*, corruptly *aſſeral*, and *aſſarth*; by the Turks, *bengitie*, and vulgarly called *maſtack*; by the European naturaliſts, *bangue* or *bange*.—It is the leaf of a kind of wild hemp, growing in the countries of the Levant:

Bangue Banians.

Levant; it differs little, either as to leaf or ſeed, from our hemp, except in ſize. Some have miſtaken it for a ſpecies of althæa.

There are divers manners of preparing it, in different countries. Olearius deſcribes the method uſed in Perſia. Mr Sale tells us, that, among the Arabs, the leaf is made into pills, or conſerves. But the moſt diſtinct account is that given by Alexander Maurocordato counſellor and phyſician of the Ottoman Porte, in a letter to Wedelius. According to this author, bangue is made of the leaves of wild hemp, dried in the ſhade, then ground to powder; and put into a pot wherein butter has been kept; ſet in an oven till it begin to torrify; then taken out, and pulverized again; thus to be uſed occaſionally, as much at a time as will lie on the point of a knife. Such is the Turkiſh bangue.—The effects of this drug are, To confound the underſtanding; ſet the imagination looſe; induce a kind of folly, and forgetfulneſs, wherein all cares are left, and joy and gaiety take take place thereof. Bangue in reality, is a ſuccedaneum to wine, and obtains in thoſe countries where Mahometaniſm is eſtabliſhed; which prohibiting the uſe of that liquor abſolutely, the poor muſſelmans are forced to have recourſe to ſuccedanea, to rouſe their ſpirits. The principal are *opium* and this bangue. As to the opinion among Europeans, that the Turks prepare themſelves for battle by a doſe of bangue, which rouſes their courage, and drives them, with eagerneſs, to certain death; Dr Maurocordato aſſures us, that it is a popular error: the Turks think they are then going aſſuredly to receive the crown of martyrdom; and would not, for any conſideration, loſe the merit of it, which they would do, by eating the bangue, as being held unlawful by their apoſtle, among other things which intoxicate.

BANIALUCH, or BAGNALUCH, a city of European Turkey, the capital of Boſnia, upon the frontiers of Dalmatia, near the river Setina. E. Long. 18. 20. N. Lat. 44. 20.

BANIANS, a religious ſect in the empire of the Mogul, who believe a metempſychoſis; and will therefore eat no living creature, nor kill even noxious animals, but endeavour to releaſe them when in the hands of others. The name of *Banian* is uſed with ſome diverſity, which has occaſioned much confuſion, and many miſtakes. Sometimes it is taken in a leſs proper ſenſe, and extended to all the idolaters of India, as contradiſtinguiſhed from the Mahometans: in which ſenſe, Banians include the Bramins and other caſts. *Banians*, in a more proper ſenſe, is reſtrained to a peculiar caſt, or tribe, of Indians, whoſe office or profeſſion is trade and merchandize; in which ſenſe, *Banians* ſtand contradiſtinguiſhed from *Bramins*, *Cuttery*, and *Wyſe*, the three other caſts, into which the Indians are divided. The four caſts are abſolutely ſeparate as to occupation, relation, marriage, &c. though all of the ſame religion; which is more properly denominated the religion of the Bramins, who make the eccleſiaſtical tribe, than of the *Banians*, who make the mercantile. The proper *Banians* are called, in the *ſhaſter*, or book of their law, by the name of *Shuddery*; under which are comprehended all who live after the manner of merchants, or that deal and tranſact for others, as brokers; excluſive of the mechanics, or artificers, who make another caſt, called *Wyſe*. Theſe *Banians* have no peculiar ſect or religion, unleſs it be, that two of the eight general precepts given by their legiſlator Bremaw to the Indian nation, are, on account of the profeſſion of the *Banians*, ſuppoſed more immediately to relate to them, viz. thoſe which enjoin veracity in their words and dealings, and avoiding all practices of circumvention in buying and ſelling.—Some of the *Banians*, quitting their poſſeſſion, and retiring from the world commence religious, aſſume a peculiar habit, and devote themſelves, more immediately to God, under the denomination of *Vertea*. Theſe, though they do not hereby change their caſt, are commonly reckoned as bramins of a more devout kind; much as monks in the Romiſh church, though frequently not in orders, are reputed as a more ſacred order than the regular clergy. The name *Banian* imports as much, in the Bramin language (wherein their law is written), as a people innocent and harmleſs; void of all guile; ſo gentle, that they cannot endure to ſee either a fly or a worm injured; and who, when ſtruck, will patiently bear it, without reſiſting or returning the blow.—Their mein and appearance is deſcribed by Lord *, in terms a little preciſe, but very ſignificant: "A people preſented themſelves to my eyes clothed in linen garments, ſomewhat low deſcending, of a geſture and garb, as I may ſay, maidenly, and well nigh effeminate, of a countenance ſhy and ſomewhat eſtranged."—Gemelli Careri divides the Banians into 22 tribes, all diſtinct, and not allowed to marry with each other. Lord aſſures us they are divided into 82 caſts or tribes, correſpondent to the caſts or diviſions of the Banians or prieſts, under whoſe diſcipline they are, as to religious matters; tho' the generality of the Banians chooſe to be under the direction of the two Bramin tribes, the Viſalnagranaugers and the Vulnagranaugers.

Banians.

* *Diſcov. Relig. Banian.*

The Banians are the great factors, by whom moſt of the trade of India is managed; in this reſpect, comparable to the Jews and Armenians, and not behind either, in point of ſkill and experience, in whatever relates to commerce. Nothing is bought but by their mediation. They ſeem to claim a kind of *jus divinum* to the adminiſtration of the traffic of the nation, grounded on their ſacred books, as the Bramins do to that of religion. They are diſperſed, for this purpoſe, through all parts of Aſia, and abound in Perſia, particularly at Iſpahan and Gombroon, where many of them are extremely rich, yet not above acting as brokers, where a penny is to be got. The chief agents of the Engliſh, Dutch, and French Eaſt India companies are of this nation: they are faithful, and are generally truſted with the caſh of thoſe companies in their keeping. They act alſo as bankers, and can give bills of exchange for moſt cities in the Eaſt Indies. Their form of contract in buying and ſelling is remarkable, being done without words, in the profoundeſt ſilence, only by touching each other's fingers: the buyer looſening his pamerin or girdle, ſpreads it on his knee, and both he and the ſeller having their hands underneath by the intercourſe of the fingers, mark the price of pounds, ſhillings, &c. demanded, offered, and at length agreed on. When the ſeller takes the buyer's whole hand, it denotes a thouſand; and as many times as he ſqueezes it, as many thouſand pagods, or roupees, according to the ſpecies in queſtion are, demanded: when he only takes the five

Banier || Bank.

fingers, it denotes five hundred, and when only one, one hundred: taking only half a finger, to the ſecond joint, denotes fifty; the ſmall end of the finger, to the firſt joint, ſtands for ten.

BANIER (Anthony), licentiate in laws, member of the academy of inſcriptions and belles lettres, and eccleſiaſtic of the dioceſe of Clermont in Auvergne; died in November 1741, aged 69. He is principally celebrated for his tranſlation of the Metamorphoſes of Ovid, with hiſtorical remarks and explanations; which was publiſhed in 1732, at Amſterdam, in folio, finely ornamented with copperplates, by Picart; and reprinted at Paris, 1738, in two vols. 4to: and for his Mythology, or fables of the ancients explained by hiſtory; a work full of the moſt important information, which was tranſlated into Engliſh, and printed at London in 1741, in 4 vols. 8vo.

BANISHMENT, exile, among us is of two kinds: the one voluntary, and upon oath; the other by compulſion, for ſome offence or crime. The former properly called *abjuration*, is now ceaſed; the latter is chiefly enjoined by judgment of Parliament. Yet outlawing and tranſportation may alſo be conſidered as ſpecies of exile.

BANISTER (John), a phyſician and ſurgeon in the reign of queen Elizabeth, was educated at Oxford where, ſays Anthony Wood, he ſtudied logicals for a time; but afterwards applied himſelf ſolely to phyſic and ſurgery. In 1573 he took the degree of bachelor of phyſic; and obtaining a licence from the univerſity to practiſe, ſettled at Notingham, where he lived many years in great repute, and wrote ſeveral medical treatiſes. His works were collected and publiſhed in 1633, 4to.

BANISTERIA, in botany; a genus of the trigynia order, belonging to the decandria claſs of plants; and in the natural method ranking under the 23d order, *Trihilatæ*. The calyx is quinquepartite, with nectarious pores on the outſide of the baſe; the petals are roundiſh and ungulated; the ſeeds are three, with membranaceous wings. There are ſeven ſpecies, all natives of warm countries, but poſſeſſing no remarkable properties.

BANK, in commerce, a common repoſitory, where many perſons agree to keep their money, to be always ready at their call or direction: or, Certain ſocieties or communities, who take the charge of other people's money, either to improve it, or to keep it ſecure.

The firſt inſtitution of banks was in Italy, where the Lombard Jews kept benches in the market-places, for the exchange of money and bills; and *banco* being the Italian name for *bench*, banks took their title from this word.

I. Company-banks.

Banks are of two principal kinds. 1. One ſort is either *public*, conſiſting of a company of monied men, who being duly eſtabliſhed and incorporated by the laws of their country, agree to depoſite a conſiderable fund, or joint ſtock, to be employed for the uſe of the ſociety, as lending money upon good ſecurity, buying and ſelling bullion, diſcounting bills of exchange, &c.: or *private*, i. e. ſet up by private perſons, or partnerſhips, who deal in the ſame way as the former upon their own ſingle ſtock and credit.

The greateſt bank of circulation in Europe, is the *Bank of England*. The company was incorporated parliament in the fifth and ſixth years of king William and queen Mary, by the name of *The Governors and Company of the Bank of England*; in conſideration of the loan of 1,200,000l. granted to the government; for which the ſubſcribers received almoſt 8 *per cent.* By this charter, the company are not to borrow under their common ſeal, unleſs by act of parliament; they are not to trade, or ſuffer any perſon in truſt for them to trade in any goods or merchandize; but they may deal in bills of exchange, in buying or ſelling bullion, and foreign gold and ſilver coin, &c.

Bank.

Bank of England; its eſtabliſhment, regulations, importance, &c.

By an act of parliament paſſed in the 8th and 9th year of William III. they were empowered to enlarge their capital ſtock to 2,201,171l. 10s. It was then alſo enacted, that bank-ſtock ſhould be a perſonal, and not a real eſtate; that no contract either in word or writing, for buying or ſelling bank-ſtock, ſhould be good in law, unleſs regiſtered in the books of the bank within 7 days, and the ſtock transferred in 14 days; and that it ſhall be felony, without benefit of clergy, to counterfeit the common ſeal of the bank, or any ſealed bank-biil, or any bank-note, or to alter or eraſe ſuch bills or notes. By another act paſſed in the 7th of queen Anne, the company were empowered to augment their capital to 4,402,343l. and they then advanced 400,000l. more to the government; and in 1714, they advanced another loan of 1,500,000l.

In the third year of the reign of king George I. the intereſt in their capital ſtock was reduced to 5 *per cent.* when the bank agreed to deliver up as many exchequer bills as amounted to 2,000,000l. and to accept an annuity of 100,000l. and it was declared lawful for the bank to call from their members, in proportion to their intereſts in the capital ſtock, ſuch ſums of money as in a general court ſhould be found neceſſary. If any member ſhould neglect to pay his ſhare of the moneys ſo called for, at the time appointed by notice in the London Gazette, and fixed upon the Royal Exchange, it ſhould be lawful for the bank, not only to ſtop the dividend of ſuch member, and to apply it towards payment of the money in queſtion, but alſo to ſtop the transfers of the ſhare of ſuch defaulter, and to charge him with an intereſt of 5 *per cent. per annum*, for the money ſo omitted to be paid: and if the principal and intereſt ſhould be three months unpaid, the bank ſhould then have power to ſell ſo much of the ſtock belonging to the defaulter as would ſatisfy the ſame. After this, the bank reduced the intereſt of the 2,000,000l. lent to the government, from 5 to 4 *per cent.* and purchaſed ſeveral other annuities, which were afterwards redeemed by the government, and the national debt due to the bank reduced to L.1,600,000. But in 1742, the company engaged to ſupply the government with 1,600,000l. at 3 *per cent.* which is now called the 3 *per cent. annuities*; ſo that the government was now indebted to the company L.3,200,000, the one half carrying 4, and the other 3 *per cent.*

In the year 1746, the company agreed that the ſum of L.986,800 due to them in the exchequer bills unſatisfied, on the duties for licences to ſell ſpirituous liquors by retail, ſhould be cancelled, and in lieu thereof to accept of an annuity of L.39,442, the intereſt of that ſum at 4 *per cent.* The company alſo agreed to advance the further ſum of L.1,000,000 into the exchequer, upon the credit of the duties ariſing by the malt

and

Bank. and land tax at 4 *per cent.* for exchequer bills to be iſſued for that purpoſe; in conſideration of which, the company were enabled to augment their capital with L.986,800; the intereſt of which, as well as that of the other annuities, were reduced to 3½ *per cent.* till the 25th of December 1757, and from that time to carry only 3 *per cent.*

And in order to enable them to circulate the ſaid exchequer bills, they eſtabliſhed what is now called *bank circulation*. The nature of which may be underſtood from what follows.

The company of the bank are obliged to keep caſh ſufficient not only to anſwer the common, but alſo any extraordinary demand that may be made upon them; and whatever money they have by them, over and above the ſum ſuppoſed neceſſary for the purpoſes, they employ in what may be called the *trade of the company*; that is to ſay, in diſcounting bills of exchange, in buying of gold and ſilver, and in government ſecurities, &c. But when the bank entered into the abovementioned contract, as they did not keep unemployed a larger ſum of money than what they deemed neceſſary to anſwer their ordinary and extraordinary demands, they could not conveniently take out of their current caſh ſo large a ſum as a million, with which they were obliged to furniſh the government, without either leſſening that ſum they employed in diſcounting, buying gold and ſilver, &c. (which would have been very diſadvantageous to them), or inventing ſome method that ſhould anſwer all the purpoſes of keeping the million in caſh. The method which they choſe, and which fully anſwers their end, was as follows:

They opened a ſubſcription, which they renew annually, for a million of money; wherein the ſubſcribers advance 10 *per cent.* and enter into a contract to pay the remainder, or any part thereof, whenever the bank ſhall call upon them, under penalty of forfeiting the 10 *per cent.* ſo advanced; in conſideration of which, the bank pays the ſubſcribers 4 *per cent.* intereſt for the money paid in, and ¾ *per cent.* for the whole ſum they agree to furniſh; and in caſe a call ſhall be made upon them for the whole, or any part thereof, the bank further agrees to pay them at the rate of 5 *per cent. per annum* for ſuch ſum till they repay it, which they are under an obligation to do at the end of the year. By this means the bank obtains all the purpoſes of keeping a million of money by them; and though the ſubſcribers, if no call is made upon them (which is in general the caſe), receive 6¾ *per cent.* for the money they advance, yet the company gains the ſum of L.23,500 *per annum* by the contract; as will appear by the following account:

	£.
The bank receives from the government for the advance of a million - -	30,000
The bank pays the ſubſcribers who advance L.100,000 and engage to pay (when called for) L.900,000 more - -	6,500
The clear gain to the bank therefore is	23,500

This is the ſtate of the caſe, provided the company ſhould make no call on the ſubſcribers; which they will be very unwilling to do, becauſe it would not only leſſen their profit, but affect the public credit in general.

Bank-ſtock may not improperly be called a *trading ſtock*, ſince with this they deal very largely in foreign gold and ſilver, in diſcounting bills of exchange, &c. Beſides which, they are allowed by the government very conſiderable ſums annually for the management of the annuities paid at their office. All which advantages render a ſhare in their ſtock very valuable; though it is not equal in value to the Eaſt India ſtock. The company make dividends of the profits half-yearly, of which notice is publicly given; when thoſe who have occaſion for their money may readily receive it; but private perſons, if they judge convenient, are permitted to continue their funds, and to have their intereſt added to the principal. Bank.

This company is under the direction of a governor, deputy-governor, and 24 directors, who are annually elected by the general court, in the ſame manner as in the Eaſt India company. Thirteen, or more, compoſe a court of directors for managing the affairs of the company. The officers of this company are very numerous.

The ſtability of the bank of England is equal to that of the Britiſh government. All that it has advanced to the public muſt be loſt before its creditors can ſuſtain any loſs. No other banking company in England can be eſtabliſhed by act of parliament, or can conſiſt of more than ſix members. It acts, not only as an ordinary bank, but (as we have already ſeen) as a great engine of ſtate; receiving and paying the greater part of the annuities which are due to the creditors of the public; circulating exchequer bills; and advancing to government the annual amount of the land and malt taxes, which are frequently not paid up till ſome years thereafter. It likewiſe has, upon ſeveral different occaſions, ſupported the credit of the principal houſes, not only of England, but of Hamburgh and Holland. Upon one occaſion it is ſaid to have advanced for this purpoſe, in one week, about L. 1,600,000, a great part of it in bullion.

In Scotland there are two public banks, both at Edinburgh. The one, called *The Bank of Scotland*, was eſtabliſhed by act of parliament in 1695; the other, called *The Royal Bank*, by royal charter in 1727. Scotch banks, public and private.

Within theſe 30 years there have alſo been erected private banking companies in almoſt every conſiderable town, and even in ſome villages. Hence the buſineſs of the country is almoſt entirely carried on by paper-currency, *i. e.* by the notes of thoſe different banking companies; with which purchaſes and payments of all kinds are commonly made. Silver very ſeldom appears, except in the change of a twenty-ſhilling bank-note, and gold ſtill ſeldomer. But though the conduct of all thoſe different companies has not been unexceptionable, and has accordingly required an act of parliament to regulate it; the country, notwithſtanding, has evidently derived great benefit from their trade. It has been aſſerted, that the trade of the city of Glaſgow doubled in about 15 years after the firſt erection of the banks there; and that the trade of Scotland has more than quadrupled ſince the firſt erection of the two public banks at Edinburgh. Whether the trade, either of Scotland in general, or of the city of Glaſgow in particular, has really increaſed in ſo great a proportion, during ſo ſhort a period, we do not pretend to know. If either of them has increaſed in this proportion, it ſeems to be an effect too great to be accounted for by

Bank. the ſole operation of this cauſe. That the trade and induſtry of Scotland, however, have increaſed very conſiderably during this period, and that the banks have contributed a good deal to this increaſe, cannot be doubted.

Smith's Wealth of Nations, Book II. chap. ii. The value of the ſilver money which circulated in Scotland before the Union in 1707, and which immediately after it was brought into the bank of Scotland in order to be recoined, amounted to L.411,117 : 10 :9 Sterling. No account has been got of the gold coin; but it appears from the ancient accounts of the mint of Scotland, that the value of the gold annually coined ſomewhat exceeded that of the ſilver. There were a good many people too upon this occaſion, who, from a diffidence of repayment, did not bring their ſilver into the bank of Scotland; and there was, beſides, ſome Engliſh coin, which was not called in. The whole value of the gold and ſilver, therefore, which circulated in Scotland before the Union, cannot be eſtimated at leſs than a million Sterling. It ſeems to have conſtituted almoſt the whole circulation of that country; for though the circulation of the bank of Scotland, which had then no rival, was conſiderable, it ſeems to have made but a very ſmall part of the whole. In the preſent times the whole circulation of Scotland cannot be eſtimated at leſs than two millions, of which that part which conſiſts in gold and ſilver moſt probably does not amount to half a million. But though the circulating gold and ſilver of Scotland have ſuffered ſo great a diminution during this period, its real riches and proſperity do not appear to have ſuffered any. Its agriculture, manufactures, and trade, on the contrary, the annual produce of its land and labour, have evidently been augmented.

Diſcounting of bills. It is chiefly by diſcounting bills of exchange, that is, by advancing money upon them before they are due, that the greater part of banks and bankers iſſue their promiſſory notes. They deduct always, upon whatever ſum they advance, the legal intereſt till the bill ſhall become due. The payment of the bill, when it becomes due, replaces to the bank the value of what had been advanced, together with a clear profit of the intereſt. The banker, who advances to the merchant whoſe bill he diſcounts, not gold and ſilver, but his own promiſſory notes, has the advantage of being able to diſcount to a greater amount, by the whole value of his promiſſory notes, which he finds by experience are commonly in circulation. He is thereby enabled to make his clear gain of intereſt on ſo much a larger ſum.

The commerce of Scotland, which at preſent is not very great, was ſtill more inconſiderable when the two firſt banking companies were eſtabliſhed; and thoſe companies would have had but little trade, had they confined their buſineſs to the diſcounting of bills of exchange. They invented, therefore, another method of iſſuing their promiſſory notes, by granting what they called *caſh accounts*; that is, by giving credit to the extent of a certain ſum (L. 2000 or L. 3000 for example), to any individual who could procure two perſons of undoubted credit and good landed eſtate to become ſurety for him, that whatever money ſhould be advanced to him within the ſum for which the credit had been given ſhould be repaid upon demand, together with the legal intereſt. Credits of this kind are commonly granted by banks and bankers in all different parts of the world. But the eaſy terms on which the Scots banking companies accept of repayment are peculiar to them, and have perhaps been the principal cauſe, both of the great trade of thoſe companies and of the benefit which the country has received from it.

Caſh-accounts.

Bank. Advantages from theſe;

Whoever has a credit of this kind with one of thoſe companies, and borrows L. 1000 upon it for example, may repay this ſum piece-meal, by L. 20 and L. 30 at a time, the company diſcounting a proportionable part of the intereſt of the great ſum from the day on which each of thoſe ſmall ſums is paid in, till the whole be in this manner repaid. All merchants therefore, and almoſt all men of buſineſs, find it convenient to keep ſuch caſh-accounts with them; and are thereby intereſted to promote the trade of thoſe companies, by readily receiving their notes in all payments, and by encouraging all thoſe with whom they have any influence to do the ſame. The banks, when their cuſtomers apply to them for money, generally advance it to them in their own promiſſory notes. Theſe the merchants pay away to the manufacturers for goods, the manufacturers to the farmers for materials and proviſions, the farmers to their landlords for rent, the landlords repay them to the merchants for the conveniences and luxuries with which they ſupply them, and the merchants again return them to the banks in order to balance their caſh accounts, or to replace what they may have borrowed of them; and thus almoſt the whole money-buſineſs of the country is tranſacted by means of them. Hence the great trade of thoſe companies.

to the banks, and

By means of thoſe caſh accounts, every merchant can, without imprudence, carry on a greater trade than he otherwiſe could do. If there are two merchants, one in London and the other in Edinburgh, who employ equal ſtocks in the ſame branch of trade, the Edinburgh merchant can, without imprudence, carry on a greater trade, and give employment to a greater number of people, than the London merchant. The London merchant muſt always keep by him a conſiderable ſum of money, either in his own coffers, or in thoſe of his banker (who gives him no intereſt for it), in order to anſwer the demands continually coming upon him for payment of the goods which he purchaſes upon credit. Let the ordinary amount of this ſum be ſuppoſed L. 500. The value of the goods in his warehouſe muſt always be leſs by L. 500 than it would have been, had he not been obliged to keep ſuch a ſum unemployed. Let us ſuppoſe that he generally diſpoſes of his whole ſtock upon hand, or of goods to the value of his whole ſtock upon hand, once in the year. By being obliged to keep ſuch a great ſum unemployed, he muſt ſell in a year L. 500 worth leſs goods than he might otherwiſe have done. His annual profits muſt be leſs by all that he could have made by the ſale of L. 500 worth more goods; and the number of people employed in preparing his goods for the market, muſt be leſs by all thoſe that L. 500 more ſtock could have employed. The merchant in Edinburgh, on the other hand, keeps no money unemployed for anſwering ſuch occaſional demands. When they actually come upon him, he ſatisfies them from his caſh-account with the bank, and gradually replaces the ſum borrowed with the money or paper which comes in from the occaſional

to the country.

Bank. casional ſale of his goods. With the ſame ſtock, therefore, he can, without imprudence, have at all times in his warehouſe a larger quantity of goods than the London merchant; and can thereby both make a greater profit himſelf, and give conſtant employment to a greater number of induſtrious people who prepare thoſe goods for the market. Hence the great benefit which the country has derived from this trade.

The late multiplication, of banking companies in both parts of the united kingdom, an event by which many people have been much alarmed, inſtead of diminiſhing increaſes the ſecurity of the public. It obliges all of them to be more circumſpect in their conduct, and by not extending their currency beyond its due proportion to their caſh, to guard themſelves againſt thoſe malicious runs which the rivalſhip of ſo many competitors is always ready to bring upon them. It reſtrains the circulation of each particular company within a narrower circle, and reduces their circulating notes to a ſmaller number. By dividing the whole circulation into a greater number of parts, the failure of any one company, an accident which, in the courſe of things, muſt ſometimes happen, becomes of leſs conſequence to the public. This free competition too obliges all bankers to be more liberal in their dealings with their cuſtomers, leſt their rivals ſhould carry them away. In general, if any branch of trade, or any diviſion of labour, be advantageous to the public, the freer and more general the competition, it will always be the more ſo. See further, the article *Paper-Money*.

II. Banks of depoſit. 2. The other kind of banks conſiſts of ſuch as are inſtituted wholly on the public account, and are called *Banks of Depoſit*; the nature of which not being generally underſtood, the following particular explanation may not be unacceptable.

Smith's Wealth of Nations. Book IV. chap. iii.

The currency of a great ſtate, ſuch as Britain, generally conſiſts almoſt entirely of its own coin. Should this currency, therefore, be at any time worn, clipt, or otherwiſe degraded below its ſtandard value the ſtate by a reformation of its coin can effectually re-eſtabliſh its currency. But the currency of a ſmall ſtate, ſuch as Genoa or Hamburgh, can ſeldom conſiſt altogether in its own coin, but muſt be made up in a great meaſure, of the coins of all the neighbouring ſtates with which its inhabitants have a continual intercourſe. Such a ſtate, therefore, by reforming its coin, will not always be able to reform its currency. If foreign bills of exchange are paid in this currency, the uncertain value of any ſum, of what is in its own nature ſo uncertain, muſt render the exchange always very much againſt ſuch a ſtate, its currency being, in all foreign ſtates neceſſarily valued even below what it is worth. In order to remedy the inconvenience to which this diſadvantageous exchange muſt have ſubjected their merchants, ſuch ſmall ſtates, when they began to attend to the intereſt of trade, have frequently enacted, that foreign bills of exchange of a certain value ſhould be paid, not in common currency, but by an order upon, or by a transfer in the books of, a certain bank, eſtabliſhed upon the credit and under the protection of the ſtate; this bank being always obliged to pay, in good and true money, exactly according to the ſtandard of the ſtate. The banks of Venice, Genoa, Amſterdam, Hamburgh, and Nuremberg, ſeem to have been originally eſtabliſhed with this view, though ſome of them may have afterwards been made ſubſervient to other purpoſes. The money of ſuch banks, being better than the common currency of the country, neceſſarily bore an agio, which was greater or ſmaller, according as the currency was ſuppoſed to be more or leſs degraded below the ſtandard of the ſtate. The agio of the bank of Hamburgh, for example, which is ſaid to be commonly about 14 *per cent.* is the ſuppoſed difference between the good ſtandard money of the ſtate, and the clipt, worn, and diminiſhed currency poured into it from all the neighbouring ſtates. Bank.

Before 1609, the great quantity of clipt and worn foreign coin, which the extenſive trade of Amſterdam brought from all parts of Europe, reduced the value of its currency about 9 *per cent.* below that of good money freſh from the mint. Such money no ſooner appeared, than it was melted down or carried away, as it always is in ſuch circumſtances. The merchants, with plenty of currency, could not always find a ſufficient quantity of good money to pay their bills of exchange; and the value of thoſe bills, in ſpite of ſeveral regulations which were made to prevent it, became in a great meaſure uncertain. In order to remedy theſe inconveniences, a bank was eſtabliſhed in 1609 under the guarantee of the city. The bank received both foreign coin, and the light and worn coin of the country, at its real and intrinſic value in the good ſtandard money of the country, deducting only ſo much as was neceſſary for defraying the expence of coinage, and the other neceſſary expence of management. For the value which remained after this ſmall deduction was made, it gave a credit in its books. This credit was called *bank-money*; which, as it repreſented money exactly according to the ſtandard of the mint, was always of the ſame real value, and intrinſically worth more than current money. It was at the ſame time enacted, that all bills drawn upon or negociated at Amſterdam of the value of 600 gilders and upwards ſhould be paid in bank-money, which at once took away all uncertainty in the value of thoſe bills. Every merchant, in conſequence of this regulation, was obliged to keep an account with the bank in order to pay his foreign bills of exchange, which neceſſarily occaſioned a certain demand for bank-money.

Bank of Amſterdam, one of the moſt famous. Its inſtitution, regulation, utility, &c.

Bank-money, over and above both its intrinſic ſuperiority to currency, and the additional value which this demand neceſſarily gives it, has likewiſe ſome other advantages. It is ſecure from fire, robbery, and other accidents; the city of Amſterdam is bound for it; it can be paid away by a ſimple transfer, without the trouble of counting, or the riſk of tranſporting it from one place to another. In conſequence of thoſe different advantages, it ſeems from the beginning to have borne an agio; and it is generally believed that all the money originally depoſited in the bank was allowed to remain there, nobody caring to demand payment of a debt which he could ſell for a premium in the market. Beſides, this money could not be brought from thoſe coffers, as it will appear by and by, without previouſly paying for the keeping.

Thoſe depoſits of coin, or which the bank was bound to reſtore in coin, conſtituted the original capital of the bank, or the whole value of what was repreſented by

what

Bank. what is called *Bank-money*. At preſent they are ſuppoſed to conſtitute but a very ſmall part of it. In order to facilitate the trade in bullion, the bank has been for theſe many years in the practice of giving credit in its books upon depoſits of gold and ſilver bullion. This credit is generally about 5 *per cent.* below the mint price of ſuch bullion. The bank grants at the ſame time what is called a *receipice* or receipt, intitling the perſon who makes the depoſit, or the bearer, to take out the bullion again at any time within ſix months, upon re-transferring to the bank a quantity of bank-money equal to that for which credit had been given in its books when the depoſit was made, and upon paying ½ *per cent.* for the keeping if the depoſit was in ſilver, and ¼ *per cent.* if it was in gold; but at the ſame time declaring, that in default of ſuch payment, and upon the expiration of this term, the depoſit ſhould belong to the bank at the price at which it had been received, or for which credit had been given in the tranſfer books. What is thus paid for the keeping of the depoſit may be conſidered as a ſort of warehouſe rent; and why this warehouſe rent ſhould be ſo much dearer for gold than for ſilver, ſeveral different reaſons have been aſſigned. The fineneſs of gold, it has been ſaid, is more difficult to be aſcertained than that of ſilver. Frauds are more eaſily practiſed, and occaſion a greater loſs in the more precious metal. Silver, beſides, being the ſtandard metal, the ſtate, it has been ſaid, wiſhes to encourage more the making of depoſits of ſilver than of thoſe of gold.

Depoſits of bullion are moſt commonly made when the price is ſomewhat lower than ordinary; and they are taken out again when it happens to riſe. In Holland the market price of bullion is generally above the mint price, for the ſame reaſon that it was ſo in England before the late reformation of the gold coin. The difference is ſaid to be commonly from about ſix to ſixteen ſtivers upon the mark, or eight ounces of ſilver of eleven parts fine and one part alloy. The bank-price, or the credit which the bank gives for depoſits of ſuch ſilver (when made in foreign coin, of which the fineneſs is well known and aſcertained, ſuch as Mexico dollars), is 22 gilders the mark; the mint price is about 23 gilders; and the market-price is from 23 gilders ſix to 23 gilders ſixteen ſtivers, or from 2 to 3 *per cent.* above the mint-price. The proportions between the bank-price, the mint-price, and the market-price, of gold bullion are nearly the ſame. A perſon can generally ſell his receipt for the difference between the mint-price of bullion and the market-price. A receipt for bullion is almoſt always worth ſomething; and it very ſeldom happens, therefore, that any body ſuffers his receipt to expire, or allows his bullion to fall to the bank at the price at which it had been received, either by not taking it out before the end of the ſix months, or by neglecting to pay the ½ or ¼ *per cent.* in order to obtain a new receipt for another ſix months. This, however, though it ſeldom happens, is ſaid to happen ſometimes, and more frequently with regard to gold than with regard to ſilver, on account of the higher warehouſe-rent which is paid for the keeping of the more precious metal.

The perſon who by making a depoſit of bullion obtains both a bank-credit and a receipt, pays his bills of exchange as they become due with his bank-credit; and either ſells or keeps his receipt, according as he judges that the price of bullion is likely to riſe or to fall. The receipt and the bank-credit ſeldom keep long together, and there is no occaſion that they ſhould. The perſon who has a receipt, and who wants to take out bullion, finds always plenty of bank-credits, or bank money to buy at the ordinary price; and the perſon who has bank-money, and wants to take out bullion, finds receipts always in equal abundance. Bank.

The owners of bank-credits and the holders of receipts conſtitute two different ſorts of creditors againſt the bank. The holder of a receipt cannot draw out the bullion for which it is granted, without re-aſſigning to the bank a ſum of bank-money equal to the price at which the bullion has been received. If he has no bank-money of his own, he muſt purchaſe it of thoſe who have it. The owner of bank-money cannot draw out bullion without producing to the bank receipts for the quantity which he wants. If he has none of his own, he muſt buy them of thoſe who have them. The holder of a receipt, when he purchaſes bank-money, purchaſes the power of taking out a quantity of bullion, of which the mint-price is 5 *per cent.* above the bank-price. The agio of 5 *per cent.* therefore, which he commonly pays for it, is paid, not for an imaginary, but for a real value. The owner of bank-money, when he purchaſes a receipt, purchaſes the power of taking out a quantity of bullion, of which the market-price is commonly from 2 to 3 *per cent.* above the mint-price. The price which he pays for it, therefore, is paid likwiſe for a real value. The price of the receipt, and the price of the bank-money, compound or make up between them the full value or price of the bullion.

Upon depoſits of the coin current in the country, the bank grants receipts likewiſe as well as bank-credits; but thoſe receipts are frequently of no value, and will bring no price in the market. Upon ducatoons, for example, which in the currency paſs for three gilders three ſtivers each, the bank gives a credit of three gilders only, or 5 *per cent.* below their current value. It grants a receipt likewiſe intitling the bearer to take out the number of ducatoons depoſited at any time within ſix months, upon paying ½ *per cent.* for the keeping. This receipt will frequently bring no price in the market. Three gilders bank-money generally ſell in the market for three gilders three ſtivers, the full value of the ducatoons if they were taken out of the bank; and before they can be taken out, ¼ *per cent.* muſt be paid for the keeping, which would be mere loſs to the holder of the receipt. If the agio of the bank, however, ſhould at any time fall to 3 *per cent.* ſuch receipts might bring ſome price in the market, and might ſell for 1¾ *per cent.* But the agio of the bank being now generally about 5 *per cent.* ſuch receipts are frequently allowed to expire, or, as they expreſs it, to fall to the bank. The 5 *per cent.* which the bank gains, when depoſits either of coin or bullion are allowed to fall to it, may be conſidered as the warehouſe rent for the perpetual keeping of ſuch depoſits.

The ſum of bank money for which the receipts are expired muſt be very conſiderable. It muſt comprehend the whole original capital of the bank, which, it is generally ſuppoſed, has been allowed to remain there from the time it was firſt depoſited, nobody caring

Bank. caring either to renew his receipt or to take out his depoſit, as, for the reaſons already aſſigned, neither the one nor the other could be done without loſs. But whatever may be the amount of this ſum, the proportion which it bears to the whole maſs of bank-mony is ſuppoſed to be very ſmall. The bank of Amſterdam has for theſe many years paſt been the great warehouſe of Europe for bullion, for which the receipts are very ſeldom allowed to expire, or, as they expreſs it, to fall to the bank. The far greater part of the bank-money, or of the credits upon the books of the bank, is ſuppoſed to have been created, for theſe many years paſt, by ſuch depoſits which the dealers in bullion are continually both making and withdrawing.

No demand can be made upon the bank but by means of a recipice or receipt. The ſmaller maſs of bank-money, for which the receipts are expired, is mixed and confounded with the much greater maſs for which they are ſtill in force; ſo that, though there may be a conſiderable ſum of bank-money for which there are no receipts, there is no ſpecific ſum or portion of it which may not at any time be demanded by one. The bank cannot be debtor to two perſons for the ſame thing; and the owner of bank-money who has no receipt cannot demand payment of the bank till he buys one. In ordinary and quiet times, he can find no difficulty in getting one to buy at the market price, which generally correſponds with the price at which he can ſell the coin or bullion it intitles him to take out of the bank.

It might be otherwiſe during a public calamity; an invaſion, for example, ſuch as that of the French in 1672. The owners of bank-money being then all eager to draw it out of the bank, in order to have it in their own keeping, the demand for receipts might raiſe their price to an exorbitant height. The holders of them might form extravagant expectations, and, inſtead of 2 or 5 *per cent.* demand half the bank-money for which credit had been given upon the depoſits that the receipts had reſpectively been granted for. The enemy, informed of the conſtitution of the bank, might even buy them up in order to prevent the carrying away of the treaſure. In ſuch emergencies, the bank, it is ſuppoſed, would break through its ordinary rule of making payment only to the holders of receipts. The holders of receipts, who had no bank-money, muſt have received within 2 or 3 *per cent.* of the value of the depoſit for which their reſpective receipts had been granted. The bank, therefore, it is ſaid, would in this caſe make no ſcruple of paying, either with money or bullion, the full value of what the owners of bank-money who could get no receipts were credited for in its books; paying at the ſame time 2 or 3 *per cent.* to ſuch holders of receipts as had no bank-money, that being the whole value which in this ſtate of things could juſtly be ſuppoſed due to them.

Even in ordinary and quiet times it is the intereſt of the holders of receipts to depreſs the agio, in order either to buy bank-money (and conſequently the bullion which their receipts would then enable them to take out of the bank) ſo much cheaper, or to ſell their receipts to thoſe who have bank-money, and who want to take out bullion, ſo much dearer; the price of a receipt being generally equal to the difference between the market-price of bank-money and that of the coin or bullion for which the receipt had been granted. It is the intereſt of the owners of bank-money on the contrary, to raiſe the agio, in order either to ſell their bank-money ſo much dearer, or to buy a receipt ſo much cheaper. To prevent the ſtock-jobbing tricks which thoſe oppoſite intereſts might ſometimes occaſion, the bank has of late years come to a reſolution to ſell at all times bank-money for currency, at 5 *per cent.* agio, and to buy it again at 4 *per cent.* agio. In conſequence of this reſolution, the agio can never either riſe above 5 or ſink below 4 *per cent.* and the proportion between the market-price of the bank and that of current money is kept at all times very near to the proportion between their intrinſic values. Before this reſolution was taken, the market-price of money uſed ſometimes to riſe ſo high as 9 *per cent.* agio, and ſometimes to ſink ſo low as par, according as oppoſite intereſts happened to influence the market. Bank.

The bank of Amſterdam profeſſes to lend out no part of what is depoſited with it, but, for every gilder for which it gives credit in its books, to keep in its repoſitories the value of a gilder either in money or bullion. That it keeps in its repoſitories all the money or bullion for which there are receipts in force, for which it is at all times liable to be called upon, and which, in reality, is continually going from it and returning to it again, cannot well be doubted. But whether it does ſo likewiſe with regard to that part of its capital for which the receipts are long ago expired, for which in ordinary and quiet times it cannot be called upon, and which in reality is very likely to remain with it for ever, or as long as the States of the United Provinces ſubſiſt, may perhaps appear more uncertain. At Amſterdam, however, no part of faith is better eſtabliſhed, than that for every gilder circulated as bank-money there is a correſpondent gilder in gold and ſilver to be found in the treaſure of the bank. The city is guarantee that it ſhould be ſo. The bank is under the direction of the four reigning burgomaſters, who are changed every year. Each new ſet of burgomaſters viſits the treaſure, compares it with the books, receives it upon oath, and delivers it over, with the ſame awful ſolemnity, to the ſet which ſucceeds it; and in that ſober and religious country oaths are not yet diſregarded. A rotation of this kind ſeems alone a ſufficient ſecurity againſt any practices which cannot be avowed. Amidſt all the revolutions which faction has ever occaſioned in the government of Amſterdam, the prevailing party has at no time accuſed their predeceſſors of infidelity in the adminiſtration of the bank. No accuſation could have affected more deeply the reputation and fortune of the diſgraced party; and if ſuch an accuſation could have been ſupported, we may be aſſured that it would have been brought. In 1672, when the French king was at Utrecht, the bank of Amſterdam paid ſo readily as left no doubt of the fidelity with which it had obſerved its engagements. Some of the pieces which were then brought from its repoſitories appeared to have been ſcorched with the fire which happened in the town-houſe ſoon after the bank was eſtabliſhed. Thoſe pieces, therefore, muſt have lain there from that time.

What may be the amount of the treaſure in the bank is a queſtion which has long employed the ſpeculations of the curious. Nothing but conjecture can be offered concerning it. It is generally reckoned, that there are about 2000 people who keep accounts with the

Bank of Banking.

the bank; and allowing them to have, one with another, the value of 1500l. lying upon their reſpective accounts, (a very large allowance), the whole quantity of bank-money, and conſequently of treaſure in the bank, will amount to 3,000,000l. or, at 21 gilders the pound Sterling, 33,000,000 of gilders; a great ſum, and ſufficient to carry on a very extenſive circulation, but vaſtly below the extravagant ideas which ſome people have formed of this treaſure.

The city of Amſterdam derives a conſiderable revenue from the bank. Beſides what may be called the *warehouſe-rent* above mentioned, each perſon, upon firſt opening an account with the bank, pays a fee of 10 gilders; and for every new account, 3 gilders 3 ſtivers; for every transfer, 2 ſtivers; and if the transfer is for leſs than 300 gilders, 6 ſtivers, in order to diſcourage the multiplicity of ſmall tranſactions. The perſon who neglects to balance his accounts twice in the year forfeits 25 gilders. The perſon who orders a transfer for more than is upon his account, is obliged to pay 3 *per cent.* for the ſum overdrawn, and his order is ſet aſide into the bargain. The bank is ſuppoſed too to make a conſiderable profit by the ſale of the foreign coin or bullion which ſometimes falls to it by the expiring of receipts, and which is always kept till it can be ſold with advantage. It makes a profit likewiſe by ſelling bank-money at 5 *per cent.* agio, and buying it at 4. Theſe different emoluments amount to a good deal more than what is neceſſary for paying the ſalaries of officers, and defraying the expence of management. What is paid for the keeping of bullion upon receipts, is alone ſuppoſed to amount to a neat annual revenue of between 150,000 and 200,000 gilders. Public utility, however, and not revenue, was the original object of this inſtitution. Its object was to relieve the merchants from the inconvenience of a diſadvantageous exchange. The revenue which has ariſen from it was unforeſeen and may be conſidered as accidental.

BANK, in ſea-affairs denotes an elevation of the ground or bottom of the ſea, ſo as ſometimes to ſurmount the ſurface of the water, or at leaſt to leave the water ſo ſhallow as uſually not to allow a veſſel to remain a-flote over it.—In this ſenſe, *bank* amounts to much the ſame as flat, ſhoal, &c. There are banks of ſand, and others of ſtone, called alſo *ſhelves*, or *rocks*. In the north ſea they alſo ſpeak of banks of ice, which are large pieces of that matter floating.

BANKER, a perſon who traffics and negociates in money; who receives and remits money from place to place by commiſſion from correſpondents, or by means of bills or letters of exchange, &c.

The ancient bankers were called *argentarii*, and *nummularii*; by the Greeks, τραπεζιται, κολλυβισται, and αργυραμοιβοι. Their chief buſineſs was to put out the money of private perſons to intereſt: they had their boards and benches, for this purpoſe, in all the markets and public places, where they took in the money from ſome, to lend it to others.

BANKING, the making of banks to oppoſe the force of the ſea, rivers, or the like, and ſecure the land from being overflowed thereby. With reſpect to the water which is to be kept out, this is called *banking*; with reſpect to the land, which is hereby to be deſended, *imbanking*.

BANKING is alſo applied to the keeping a bank, or the employment of a banker. Banking, in this ſenſe, ſignifies the trading in money, or remitting it from place to place, by means of bills of exchange. This anſwers to what the French call *faire le banque*. In France, every body is allowed to bank, whether merchant or not; even foreigners are indulged in this kind of traffic. In Italy, banking does not derogate from nobility, eſpecially in the republic ſtates; whence it is, that moſt of the younger ſons of great families engage in it. In reality, it was the nobility of Venice and Genoa, that, for a long time, were the chief bankers in the other countries of Europe.

Bankiſh Bankrupt.

BANKISH, a province of the Mogul's dominions, in the north part of the Hither India, lying ſouth-weſt of the province of Caſſimere.

BANKRUPT, (*bancus ruptus*), is ſo called, becauſe, when the bank or ſtock is broken or exhauſted, the owner is ſaid to be a *bankrupt*. And this word *bankrupt* is derived from the French *banqueroute*, which ſignifies a breaking or failing in the world: *banque* in French is as much as *menſa* in Latin, and *route* is the ſame as *veſtigium*; and this term is ſaid to be taken originally from the Roman *menſarii*, which were ſet in public places; and when a tradeſman ſlipped away, with an intention to deceive his creditors, he left only ſome *veſtigia* or ſigns of his table or ſhop behind him. But a bankrupt with us, from the ſeveral deſcriptions given of him in our ſtatute-law, may be defined "a trader, who ſecretes himſelf, or does certain other acts tending to defraud his creditors." For the better underſtanding of this article, it will be proper to conſider, 1. *Who* may become a bankrupt: 2. What *acts* make a bankrupt: 3. The *proceedings* on a commiſſion of bankruptcy: and, 4. In what manner an eſtate in goods and chattels may be *transferred* by bankruptcy.—But of theſe, the two laſt being treated under the article COMMISSION *of Bankruptcy*, the two firſt only belong to this place.

1. A bankrupt was formerly conſidered merely in the light of a criminal or offender; and in this ſpirit we are told by Sir Edward Coke, that we have fetched as well the name, as the wickedneſs, of bankrupts from foreign nations. But at preſent the laws of bankruptcy are conſidered as laws calculated for the benefit of trade, and founded on the principles of humanity as well as juſtice; and to that end they confer ſome privileges, not only on the creditors, but alſo on the bankrupt or debtor himſelf. On the creditors; by compelling the bankrupt to give up all his effects to their uſe, without any fraudulent concealment: on the debtor; by exempting him from the rigor of the general law, whereby his perſon might be confined at the diſcretion of his creditor, though in reality he has nothing to ſatisfy the debt; whereas the law of bankrupts, taking into conſideration the ſudden and unavoidable accidents to which men in trade are liable, has given them the liberty of their perſons, and ſome pecuniary emoluments, upon condition they ſurrender up their whole eſtate to be divided among their creditors.

In this reſpect the legiſlature ſeems to have attended to the example of the Roman law. We mean not the terrible law of the twelve tables; whereby the creditors might cut the debtor's body into pieces, and each of them take his proportionable ſhare: if indeed that law, *de debitore in partes ſecando*, is to be underſtood in ſo very butcherly a light: which many learned men have with

Blackſt. Comm. II. 472, &c.

Bankrupt.

with reaſon doubted. Nor do we mean thoſe leſs inhuman laws (if they may be called ſo, as *their* meaning is indiſputably certain), of impriſoning the debtor's perſon in chains; ſubjecting him to ſtripes and hard labour, at the mercy of his rigid creditor; and ſometimes ſelling him, his wife and children, to perpetual foreign ſlavery *trans Tiberim* (A): an oppreſſion, which produced ſo many popular inſurrections, and ſeceſſions to the *mons ſacer*. But we mean the law of ceſſion, introduced by the Chriſtian emperors; whereby, if a debtor *ceded* or yielded up all his fortune to his creditors, he was ſecured from being dragged to a gaol, "*omni quoque corporali cruciatu ſemoto.*" For, as the emperor juſtly obſerves, "*inhumanum erat ſpoliatum fortunis ſuis in ſolidum damnari.*" Thus far was juſt and reaſonable: but as the departing from one extreme is apt to produce its oppoſite, we find it afterwards enacted, that if the debtor by any unforeſeen accident was reduced to low circumſtances, and would ſwear that he had not ſufficient left to pay his debts, he ſhould not be compelled to cede or give up even that which he had in his poſſeſſion; a law which, under a falſe notion of humanity, ſeems to be fertile of perjury, injuſtice, and abſurdity.

The laws of England, more wiſely, have ſteered in the middle between both extremes: providing at once againſt the inhumanity of the creditor, who is not ſuffered to confine an honeſt bankrupt after his effects are delivered up, and at the ſame time taking care that all his juſt debts ſhall be paid, ſo far as the effects will extend. But ſtill they are cautious of encouraging prodigality and extravagance by this indulgence to debtors: and therefore they allow the benefit of the laws of bankruptcy to none but actual traders; ſince that ſet of men are, generally ſpeaking, the only perſons liable to accidental loſſes, and to an inability of paying their debts, without any fault of their own. If perſons in other ſituations of life run in debt without the power of payment, they muſt take the conſequences of their own indiſcretion, even though they meet with ſudden accidents that may reduce their fortunes: for the law holds it to be an unjuſtifiable practice, for any perſon but a trader to encumber himſelf with debts of any conſiderable value. If a gentleman, or one in a liberal profeſſion, at the time of contracting his debts, has a ſufficient fund to pay them, the delay of payment is a ſpecies of diſhoneſty, and a temporary injuſtice to his creditor: and if, at ſuch time, he has not ſufficient fund, the diſhoneſty and injuſtice is the greater. He cannot therefore murmur, if he ſuffers the puniſhment which he has voluntarily drawn upon himſelf. But in mercantile tranſactions the caſe is far otherwiſe. Trade cannot be carried on without mutual credit on both ſides: the contracting of debts is therefore here not only juſtifiable but neceſſary. And if by accidental calamities, as by the loſs of a ſhip in a tempeſt, the failure of brother traders, or by the non-payment of perſons out of trade, a merchant or trader becomes incapable of diſcharging his own debts, it is his misfortune and not his fault. To the misfortunes therefore of debtors, the law has given a compaſſionate remedy, but denied it to their faults: ſince, at the ſame time that it provides for the ſecurity of commerce, by enacting that every conſiderable trader may be declared a bankrupt, for the benefit of his creditors as well as himſelf, it has alſo, to diſcourage extravagance, declared that no one ſhall be capable of being made a bankrupt, but only a trader; nor capable of receiving the full benefit of the ſtatutes, but only an induſtrious trader.

Bankrupt.

In the interpretation of the ſeveral ſtatutes made concerning Engliſh bankrupts, *, it hath been held, that buying only, or ſelling only, will not qualify a man to be a bankrupt; but it muſt be both buying and ſelling, and alſo getting a livelihood by it: as, by exerciſing the calling of a merchant, a grocer, a mercer, or, in one general word, a *chapman*, who is one that buys and ſells any thing. But no handicraft occupation (where nothing is bought or ſold, and therefore an extenſive credit, for the ſtock in trade, is not neceſſary to be had) will make a man a regular bankrupt; as that of a huſbandman, a gardener, and the like, who are paid for their work and labour. Alſo an inn-keeper cannot, as ſuch be a bankrupt: for his gain or livelihood does not ariſe from buying and ſelling in the way of merchandize, but greatly from the uſe of his rooms and furniture, his attendance, and the like: and though he may buy corn and victuals, to ſell again at a profit, yet that no more makes him a trader, than a ſchoolmaſter or other perſon is, that keeps a boarding-houſe, and makes conſiderable gains by buying and ſelling what he ſpends in the houſe, and ſuch a one is clearly not within the ſtatutes. But where perſons buy goods, and make them up into ſaleable commodities, as ſhoemakers, ſmiths, and the like; here, though part of the gain is by bodily labour, and not by buying and ſelling, yet they are within the ſtatutes of bankrupts; for the labour is only in melioration of the commodity, and rendering it more fit for ſale.

* 34 Hen. VIII. c. 4. 13 Eliz. c. 7. 21 Jac. I. c. 19. 5 Geo. II. c. 30.

2. To learn what the *acts* of bankruptcy are which render a man a bankrupt, we muſt conſult the ſeveral ſtatutes, and the reſolutions formed by the courts thereon. Among theſe may therefore be reckoned, 1. Departing from the realm, whereby a man withdraws himſelf from the juriſdiction and coërcion of the law, with an intent to defraud his creditors. 2. Departing from his own houſe, with intent to ſecrete himſelf and avoid his creditors. 3. Keeping in his own houſe, privately, (except for juſt and neceſſary cauſe), ſo as not to be ſeen or ſpoken with by his creditors; which is likewiſe conſtrued to be an intention to defraud his creditors, by avoiding the proceſs of the law. 4. Procuring or ſuffering himſelf willingly to be arreſted, or outlawed, or impriſoned, without juſt and lawful cauſe; which is likewiſe deemed an attempt to defraud his creditors. 5. Procuring his money, goods, chattels, and effects, to be attached or ſequeſtrated by any legal proceſs; which is another plain and direct endeavour to diſappoint his creditors of their ſecurity. 6. Making any fraudulent conveyance to a friend, or

(A) In Pegu, and the adjacent countries in Eaſt India, the creditor is entitled to diſpoſe of the debtor himſelf, and likewiſe of his wife and children: inſomuch that he may even violate with impunity, the chaſtity of the debtor's wife; but then, by ſo doing, the debt is underſtood to be diſcharged.

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ſecret truſtee, of his lands, tenements, goods, or chattels; which is an act of the ſame ſuſpicious nature with the laſt. 7. Procuring any protection, not being himſelf privileged by parliament, in order to ſcreen his perſon from arreſts; which alſo is an endeavour to elude the juſtice of the law. 8. Endeavouring, or deſiring, by any petition to the king, or bill exhibited in any of the king's courts againſt any creditors, to compel them to take leſs than their juſt debts; or to procraſtinate the time of payment, originally contracted for; which are an acknowledgment of either his poverty or his knavery. 9. Lying in priſon for two months, or more, upon an arreſt or other detention for debt, without finding bail, in order to obtain his liberty. For the inability to procure bail argues a ſtrong deficiency in credit, owing either to his ſuſpected poverty, or his ill character; and his neglect to do it, if able, can ariſe only from a fraudulent intention: in either of which caſes, it is high time for his creditors to look to themſelves, and compel a diſtribution of his effects. 10. Eſcaping from priſon after an arreſt for a juſt debt of L.100, or upwards. For no man would break priſon, that was able and deſirous to procure bail; which brings it within the reaſon of the laſt caſe. 11. Neglecting to make ſatisfaction for any juſt debt to the amount of L.100, within two months after ſervice of legal proceſs, for ſuch a debt, upon any trader having privilege of parliament.

Theſe are the ſeveral acts of bankruptcy expreſsly defined by the ſtatutes relating to this article; which being ſo numerous, and the whole law of bankrupts being an innovation on the common law, our courts of juſtice have been tender of extending or multiplying acts of bankruptcy by any conſtruction or implication. And therefore Sir John Holt held, that a man's removing his goods privately to prevent their being ſeized in execution, was no act of bankruptcy. For the ſtatutes mention only fraudulent gifts to third perſons, and procuring them to be ſeized by ſham proceſs, in order to defraud creditors; but this, though a palpable fraud, yet, falling within neither of thoſe caſes, cannot be adjudged an act of bankruptcy. So alſo it has been determined expreſsly, that a banker's ſtopping or refuſing payment is no act of bankruptcy: for it is not within the deſcription of any of the ſtatutes; and there may be good reaſons for his ſo doing, as ſuſpicion of forgery and the like: and if, in conſequence of ſuch a refuſal, he is arreſted, and puts in bail, ſtill it is no act of bankruptcy; but if he goes to priſon, and lies there two months, then, and not before, is he become a bankrupt.

As to the conſequences reſulting from the unhappy ſituation of a bankrupt, ſee the article *Commission of Bankruptcy*.

BANKS (John), a dramatic writer, was bred to the law, and belonged to the ſociety of Gray's Inn; but this profeſſion not ſuiting his natural diſpoſition, he quitted it for the ſervice of the muſes. Here, however, he found his rewards by no means adequate to his deſerts. His emoluments at the beſt were precarious, and the various ſucceſſes of his pieces too feelingly convinced him of the error in his choice. This, however, did not prevent him from purſuing with cheerfulneſs the path he had taken; his thirſt of fame, and warmth of poetic enthuſiaſm, alleviating to his imagination many diſagreeable circumſtances into which indigence, the too frequent attendant on poetical purſuits, frequently threw him. His turn was entirely to tragedy, his merit in which is of a peculiar kind. For at the ſame time that his language muſt be confeſſed to be extremely unpoetical, and his numbers uncouth and unharmonious; nay, even his characters very far from being ſtrongly marked or diſtinguiſhed, and his epiſodes extremely irregular: yet it is impoſſible to avoid being deeply affected at the repreſentation, and even at the reading of his tragic pieces. This is owing in the general to an happy choice of his ſubjects; which are all borrowed from hiſtory, either real or romantic; and indeed the moſt of them from circumſtances in the annals of our own country, which, not only from their being familiar to our continual recollection, but even from their having ſome degree of relation to ourſelves, we are are apt to receive with a kind of partial prepoſſeſſion, and a predetermination to be pleaſed. He has conſtantly choſen as the baſis of his plays ſuch tales as were in themſelves and their well-known cataſtrophes moſt truly adapted to the purpoſes of the drama. He has indeed but little varied from the ſtrictneſs of hiſtorical facts; yet he ſeems to have made it his conſtant rule to keep the ſcene perpetually alive, and never ſuffer the characters to droop. His verſe is not poetry, but proſe run mad. Yet will the falſe gem ſometimes approach ſo near in glitter to the true one, at leaſt in the eyes of all but the real connoiſſeurs (and how ſmall a part of an audience are to be ranked in this claſs will need no ghoſt to inform us), that bombaſt will frequently paſs for the true ſublime; and where it is rendered the vehicle of incidents in themſelves affecting, and in which the heart is apt to intereſt itſelf, it will perhaps be found to have a ſtronger power on the human paſſions than even that property to which it is in reality no more than a bare ſuccedaneum. And from theſe principles it is that we muſt account for Mr Banks's writings having in the general drawn more tears from, and excited more terror in, even judicious audiences, than thoſe of much more correct and more truly poetical authors. The tragedies he has left behindare, 1. *Albion Queens*. 2. *Cyrus the Great*. 3. *Deſtruction of Troy*. 4. *Innocent Uſurper*. 5. *Iſland Queens*. This is only the Albion Queens altered. 6. *Rival Kings*. 7. *Virtue betrayed*. 8. *Unhappy Favourite*. The Albion Queens was rejected by the managers in 1604; but was acted by Queen Anne's command in 1706, with great applauſe, and has been ſeveral times revived. The Unhappy favourite continued till very lately a ſtock tragedy at the theatres: but gives way at preſent to the latter tragedies from the ſame ſtory, by Jones and Brooke.—Neither the time of the birth nor that of the death of this author, are aſcertained. His remains, however, lie interred in the church of St James's, Weſtminſter.

Banks, Banks's.

BANKS's ISLAND, a ſmall iſland in the South Sea diſcovered by Captain Cook in 1770, in S. Lat. 53. 32. W. Long. 186. 30. It is of a circular figure; and about 24 leagues in compaſs: it is ſufficiently high to be ſeen at the diſtance of 21 or 15 leagues; and the land has a broken irregular ſurface, with the appearance of barrenneſs rather than fertility. It is, however, inhabited, as ſome ſtraggling ſavages were obſerved upon it.

BANK-

Banksia | Bann.

BANKSIA, in botany; a genus of the monogynia order, belonging to the tetrandia claſs of plants. The amentum is ſcaly, the corolla conſiſts of four petals; the antheræ are in the cavity of the folds, and foſſile; the capſule is bivalvular; and the ſeed is ſolitary, and bipartic. There are four ſpecies, the ſerrata, integrifolia, eridæ folia, and dentata, all natives of New Holland.

BANN, or BAN (from the Brit. *ban*, i. e. clamour), is a proclamation or public notice; any public ſummons or edict, whereby a thing is commanded or forbidden. It is a word ordinary among the feudiſts; and there is both *banus* and *banum*, which ſignify two ſeveral things.—The word *banns* is particularly uſed in England in publiſhing matrimonial contracts; which is done in the church before marriage, to the end that if any perſons can ſpeak againſt the intention of the parties, either in reſpect of kindred, precontract, or for other juſt cauſe, they may take their exception in time, before marriage is conſummated; and in the canon law, Bannæ *ſunt proclamationes ſponſi et ſponæ in eccleſiis fieri ſolitæ*. But there may be a faculty or licence for the marriage, and then this ceremony is omitted; and miniſters are not to celebrate matrimony between any perſons without a licence, except the banns have been firſt publiſhed three ſeveral times, upon pain of ſuſpenſion, &c. Can. 62.

The uſe of matrimonial banns is ſaid to have been firſt introduced in the Gallican church, though ſomething like it obtained even in the primitive times; and it is this that Tertullian is ſuppoſed to mean by *trinundina promulgatio*. The council of Lateran firſt extended, and made the uſage general. By the ordinance of Blois, no perſon could validly contract marriage, without a preceding proclamation of three banns; nor could any perſon whatever be diſpenſed with, except for the two laſt. But the French themſelves have abated much of this ſeverity; and only minors are now under an abſolute neceſſity of ſubmitting to the formality of banns. For majors, or thoſe of age, after publication of the firſt banns, the two latter are eaſily bought off.

BANN, is alſo uſed to denote proſcription or baniſhment for a crime proved; becauſe anciently publiſhed by ſound of trumpet; or, as Voſſius thinks, becauſe thoſe who did not appear at the abovementioned ſummons, were puniſhed by proſcription. Hence, *to put a prince under the bann of the empire*, is to declare him diveſted of all his dignities. The ſentence only denotes an interdict of all intercourſe, and offices of humanity, with the offender; the form of which ſeems taken from that of the Romans, who baniſhed perſons by forbidding them the uſe of fire and water. Sometimes alſo cities are put under the imperial bann; that is, ſtripped of their rights and privileges.

BANN alſo denotes a pecuniary mulct, or penalty, laid on a delinquent for offending againſt a bann.

BANN, or BANNUS, a title anciently given to the governor or viceroy of Croatia, Dalmatia, and Sclavonia.

Epiſcopal BANN, (*Bannus Epiſcopalis*), a mulct paid to the biſhop by thoſe guilty of ſacrilege and other crimes.

BANN, is alſo uſed for a ſolemn anathema, or excommunication, attended with curſes, &c. In this ſenſe we read of *papal banns*, &c. Bann | Banneret.

BANN, in military affairs, a proclamation made in the army by beat of drum, ſound of trumpet, &c. requiring the ſtrict obſervance of diſcipline, either for the declaring a new officer, or puniſhing an offender.

BANNER denotes either a ſquare flag, or the principal ſtandard belonging to a prince.

We find a multiplicity of opinions concerning the etymology of the word *banner*; ſome deriving it from the Latin *bandum*, "a band or flag;" others from the word *bann*, "to ſummon the vaſſals to appear in arms;" others again from the German *ban*, "a field or tenement," becauſe landed men alone were allowed a banner: and, finally, there are ſome who think it is a corruption of *panniere*, from *pannus*, "cloth," becauſe banners were originally made of cloth.

The BANNER *of France*, was the largeſt and richeſt of all the flags borne by the ancient kings in their great military expeditions. St Martin's cap was in uſe 600 years as the banner of France; it was made of taffety, painted with the image of that ſaint, and laid one or two days on his tomb to prepare it for uſe. About the year 1100 came in a more pompous apparatus. The banner royal was faſtened to the top of a maſt, or ſome tall tree, planted on a ſcaffold, borne on a carriage drawn by oxen, covered with velvet houſings, decorated with devices or cyphers of the prince reigning. At the foot of the tree was a prieſt who ſaid maſs early every morning. Ten knights mounted guard on the ſcaffold night and day, and as many trumpets at the foot of the tree never ceaſed flouriſhing, to animate the troops. This cumberſome machine, the mode of which was brought from Italy, continued in uſe about 130 years. Its poſt was in the centre of the army. And here it was that the chief feats were performed, to carry off and defend the royal banner; for there was no victory without it, nor was any army reputed vanquiſhed till they had loſt their banner.

BANNERETS, an ancient order of knights or feudal lords; who poſſeſſing ſeveral large fees, led their vaſſals to battle under their own flag or banner, when ſummoned thereto by the king. The word ſeems formed from *banner*, "a ſquare flag;" or from *band*, which anciently denoted a flag.—Bannerets are alſo called in ancient writers *milites vexilliferi*, and *vexillarii bannerarii*, *bannarii*, *banderiſii*, &c.

Anciently there were two kinds of knights, *great* and *little*; the firſt whereof were called *bannerets*, the ſecond *bachelors*; the firſt compoſed the upper, the ſecond the middle, nobility.

The banneret was a dignitary allowed to march under his own flag, whereas the *bachelarius eques* followed that of another. To be qualified for a banneret, one muſt be a gentleman of family, and muſt have a power to raiſe a certain number of armed men, with eſtate enough to ſubſiſt at leaſt 28 or 30 men. This muſt have been very conſiderable in thoſe days; becauſe each man, beſides his ſervant, had two horſemen to wait on him armed, the one with a croſs-bow, the other with a bow and hatchet. As he was not allowed to be a baron who had not above 13 knights fees, ſo he was not admitted to be a banneret if he had leſs than 10.

Banneret, Bannock.

Banneret, according to Spelman, was a middle order between a baron and a ſimple knight; called ſometimes alſo *vexillarius minor*, to diſtinguiſh him from the greater, that is, from the baron, to whom alone properly belonged the *jus vexilli*, or privilege of the ſquare flag. Hence the banneret was alſo called *bannerettus, quaſi baro minor*; a word frequently uſed by Engliſh writers in the ſame ſenſe as banneret was by the French, though neither of them occur before the time of Edward II.

Some will have bannerets to have originally been perſons who had ſome portion of a barony aſſigned them; and enjoyed it under the title of *baro proximus*, and that with the ſame prerogatives as the baron himſelf. Some, again, find the origin of bannerets in France, others in Brittany, others in England. Theſe laſt attribute the inſtitution of bannerets to Conan, lieutenant of Maximus, who commanded the Roman legions in England under the empire of Gratian in 383. This general, ſay they, revolting, divided England into 40 cantons, and in theſe cantons diſtributed 40 knights; to whom he gave a power of aſſembling, on occaſion, under their ſeveral banners, as many of the effective men as were found in their reſpective diſtricts: whence they are called *bannerets*. However this be, it appears from Froiſſart, &c. that anciently ſuch of the military men as were rich enough to raiſe and ſubſiſt a company of armed men, and had a right to do ſo, were called *bannerets*. Not, however, that theſe qualifications rendered them knights, but only bannerets; the appellation of *knight* being only added thereto, becauſe they were ſimple knights before.

Bannerets were ſecond to none but knights of the garter. They were reputed the next degree below the nobility; and were allowed to bear arms with ſupporters, which none elſe may under the degree of a baron. In France, it is ſaid, the dignity was hereditary; but in England it died with the perſon that gained it. The order dwindled on the inſtitution of baronets by King James I. and at length became extinct. The laſt perſon created banneret was Sir John Smith, made ſo after Edghill-fight, for reſcuing the ſtandard of King Charles I.

The form of the banneret's creation was this. On a day of battle, the candidate preſented his flag to the king or general; who, cutting off the train or ſkirt thereof, and making it a ſquare, returned it again, the proper banner of bannerets; who are hence ſometimes called *knights of the ſquare flag*. There ſeems to have been bannerets created either in a different manner, or by others than the ſovereign; ſince King James, in the patent of baronets, gives them precedence to all knights bannerets, except ſuch as are created by the king himſelf in the field; which implies, either that there are ſome of this order created out of the field, or by inferior perſons.

BANNERET is alſo the name of an officer or magiſtrate of Rome towards the cloſe of the 14th century. —The people of that city, and throughout the territory of the church, during the diſputes of the antipopes, had formed a kind of republican government; where the whole power was lodged in the hands of a magiſtrate called *ſenator*, and twelve heads of quarters called *bannerets*, by reaſon of the banners which each raiſed in his diſtrict.

BANNOCK, a kind of oat-cake, baked in the embers, or on a ſtone placed before the fire. It is common in the northern parts of Scotland.

Bannum. ‖ Bantam.

BANNUM, in law, ſignifies the utmoſt bounds of a manor or town.

BANQUET, a feaſt or entertainment where people regale themſelves with pleaſant foods or fruits.

BANQUET, in the menage, that ſmall part of the branch of a bridle that is under the eye; which being rounded like a ſmall rod, gathers and joins the extremities of the bit to the branch in ſuch a manner that the banquet is not ſeen, but covered by the cope, or that part of the bit that is next the branch.

BANQUET-Line, an imaginary line drawn, in making a bit, along the banquet, and prolonged up or down, to adjuſt the deſigned force or weakneſs of the branch, in order to make it ſtiff or eaſy.

BANQUET, or *Banquette*, in fortification, a little foot-bank, or elevation of earth, forming a path which runs along the inſide of a parapet, upon which the muſketeers get up, in order to diſcover the counterſcarp, or to fire on the enemy, in the moat or in the covert-way.

BANQUETING ROOM or HOUSE. See SALOON. The ancient Romans ſupped in the atrium, or veſtibule, of their houſes; but, in after-times, magnificent ſaloons, or banqueting-rooms, were built, for the more commodious and ſplendid entertainment of their gueſts. Lucullus had ſeveral of theſe, each diſtinguiſhed by the name of ſome god; and there was a particular rate of expence appropriated to each. Plutarch relates with what magnificence he entertained Cicero and Pompey, who went with deſign to ſurpriſe him, by telling only a ſlave who waited, that the cloth ſhould be laid in the Apollo. The emperor Claudius, among others, had a ſplendid banqueting-room named *Mercury*. But every thing of this kind was outdone by the luſtre of that celebrated banqueting-houſe of Nero, called *domus aurea*; which, by the circular motion of its partitions and ceilings, imitated the revolution of the heavens, and repreſented the different ſeaſons of the year, which changed at every ſervice, and ſhowered down flowers, eſſences, and perfumes, on the gueſts.

BANSTICKLE, in ichthyology. See GASTEROSTEUS.

BANTAM, a large town of the iſland of Java, in the Eaſt Indies, ſituated in E. Long. 105. 16. S. Lat. 6. 20. It is the capital of a kingdom of the ſame name, with a good harbour and fortified caſtle. It is divided into two towns ſeparated by a river, and one of them inhabited by the Chineſe. For its hiſtory, &c. ſee JAVA.

BANTAM-WORK, a kind of painted or carved work, reſembling that of Japan, only more gaudy.

There are two ſorts of Bantam, as well as of Japan work. As, in the latter, ſome are flat, lying even with the black, and others high and emboſſed; ſo, in Bantam-work, ſome are flat, and others in-cut, or carved into the wood, as we find in many large ſcreens: with this difference, that the Japan artiſts work chiefly in gold and other metals; and thoſe of Bantam generally in colours, with a ſmall ſprinkling of gold here and there: for the flat Bantam-work is done in colours, mixed with gum-water, proper for the thing deſigned to be imitated. For the carved, or in-cut kind, the method of performing it is thus deſcribed by an ingenious

Bantry | Baptiſm.

genious artiſt: 1. The wood is to be primed with whiting and ſize, ſo often, till the primer lie near a quarter of an inch thick; then it is to be water-plained, *i. e.* rubbed with a fine wet cloth, and, ſome time after, rubbed very ſmooth, the blacks laid on, varniſhed up with a good body, and poliſhed well, though with a gentle hand. This done, the deſign is to be traced out with vermilion and gum-water, exactly in the manner wherein it is intended to be cut; the figures, trees, buildings, &c. in their due proportion: then the graver is applied, with other tools of proper ſhapes, differing according to the workman's fancy: with theſe he cuts deep or ſhallow, as is found convenient, but never deeper than the whiting lies, the wood being never to feel the edge of the inſtrument. Lines, or parts of the black, are ſtill to be left for the draperies, and other out-lines, and for the diſtinction of one thing from another; the rule being to cut where the white is, and leave the black untouched. The carving being finiſhed, then take to the pencil, with which the colours are laid into the cut-work: after this, the gold is to be lain in thoſe places which the deſign requires; for which purpoſe, a ſtrong thick gum-arabic water is taken and laid with a pencil on the work; and, while this remains wet, leaf-gold is cut with a ſharp ſmooth edged knife, in little pieces, ſhaped to the bigneſs and figure of the places where they are to be laid. Theſe being taken up with a little cotton, they daub them with the ſame cloſe to the gum-water, which affords a rich luſtre. The work thus finiſhed, they clear up the black with oil, taking care not to touch the colours. The European workmen ordinarily uſe braſs-duſt, which is leſs bright and beautiful.

BANTRY, a town of Ireland, in the county of Cork, and province of Munſter. It is ſeated on a bay of the ſame name, in W. Long. 9. 15. N. Lat. 51. 30.

BAOBAB, the name given by Proſper Alpinus to the African calabaſh-tree, ſince called ADANSONIA. See that article.

BAPTISM, in matters of religion, the ceremony of waſhing; or a ſacrament, by which a perſon is initiated into the Chriſtian church.—The word is formed from the Greek βαπτιζω, of βαπτω *to dip*, or *waſh*. Baptiſm is known, in eccleſiaſtical writers, by divers other names and titles. Sometimes it is called *paliugeneſia*, or *laver of regeneration*; ſometimes *ſalus*, or *life and ſalvation*; ſometimes σφραγις, *ſignaculum Domini*, and *ſignaculum fidei*, or *the ſeal of faith*; ſometimes abſolutely *myſterium*, and *ſacramentum*; ſometimes *the ſacrament of faith*; ſometimes *viaticum*, from its being adminiſtered to departing perſons; ſometimes *ſacerdotium laici*, or *the lay prieſthood*, becauſe allowed, in caſes of neceſſity, to be conferred by laymen: ſometimes it is called the *great circumciſion*, becauſe it was imagined to ſucceed in the room of circumciſion, and to be a ſeal of the Chriſtian covenant, as that was the ſeal of the covenant made with Abraham: ſo, in regard that baptiſm had Chriſt for its author, and not man, it was anciently known by the name of δωρον and χαρισμα Κυριυ, *the gift of the Lord*: ſometimes it was ſimply called δωρον, without any other addition, by way of eminence, becauſe it was both a gratuitous and ſingular gift of Chriſt: in reference to the making men complete members of Chriſt's body, the church, it had the name of τελειωσις, and τελειν, the *conſecration* and *conſummation*; becauſe it gave men the perfection of Chriſtians, and a right to partake of the Το Τελειον, which was *the Lord's Supper*: it had alſo the name of μυησις and μυεταγωγια, the *initiation*, becauſe it was the admittance of men to all the ſacred rites and myſteries of the Chriſtian religion. Baptiſm.

Various names given to baptiſm.

Bingham's Orig. Eccleſ.

Baptiſm has been ſuppoſed by many learned authors to have had its origin from the Jewiſh church, in which, as they maintain, it was the practice long before Chriſt's time, to baptize proſelytes or converts to their faith, as part of the ceremony of their admiſſion; a practice which, according to ſome, obtains among them to this day; a perſon turning Jew, is firſt circumciſed, and, when healed, is bathed, or baptized in water, in preſence of their rabbins; after which he is reputed a good Jew. Others, however, inſiſt that the Jewiſh proſelyte baptiſm is not by far ſo ancient, and that John the Baptiſt was the firſt adminiſtrator of baptiſm among the Jews. Of this opinion were Deylingius, J. G. Carpzovius, Boernerus, Wernſdorfius, Zeltnerus, Owen, Knatchbull, Jennings, Gill, and others. Its origin, &c.

Grotius is of opinion, that the rite of baptiſm had its original from the time of the deluge; immediately after which, he thinks, it was inſtituted in memory of the world having been purged by water. Some learned men think it was added to circumciſion, ſoon after the Samaritan ſchiſm, as a mark of diſtinction to the orthodox Jews. Spencer, who is fond of deriving the rites of the Jewiſh religion from the ceremonies of the Pagans, lays it down as a probable ſuppoſition, that the Jews received the baptiſm of proſelytes from the neighbouring nations, who were wont to prepare candidates for the more ſacred functions of their religion, by a ſolemn ablution; that, by this affinity of ſacred rites, they might draw the Gentiles to embrace their religion, and that the proſelytes (in gaining of whom they were extremely diligent) might the more eaſily comply with the tranſition from Gentiliſm to Judaiſm. In confirmation of this opinion, he obſerves, firſt, that there is no divine precept for the baptiſm of proſelytes, God having enjoined only the rite of circumciſion for the admiſſion of ſtrangers into the Jewiſh religion. Secondly, that, among foreign nations, the Egyptians, Perſians, Greeks, Romans, and others, it was cuſtomary that thoſe who were to be initiated into their myſteries, or ſacred rites, ſhould be firſt purified by dipping their whole body in water. That learned writer adds, as a farther confirmation of his opinion, that the cup of bleſſing likewiſe, added to the paſchal ſupper, ſeems plainly to have been derived from a pagan original: for the Greeks, at their feaſts, had one cup called ποτηριον αγαθυ δαιμονος, *the cup of the good dæmon or god*, which they drank at the concluſion of their entertainment, when the table was removed. Since, then, a rite of Gentile origin was added to one of the Jewiſh ſacraments, viz. the paſſover, there can be no abſurdity in ſuppoſing, that baptiſm, which was added to the other ſacrament, namely circumciſion, might be derived from the ſame ſource. In the laſt place, he obſerves, that Chriſt, in the inſtitution of his ſacraments, paid a peculiar regard to thoſe rites which were borrowed from the Gentiles: for, rejecting circumciſion and the paſchal ſupper, he adopted into his religion baptiſm and the ſacred cup; thus preparing the way for the converſion and reception of the Gentiles into his church.

The

Baptiſm. The deſign of the Jewiſh baptiſm, if baptiſm be practiſed by them, is ſuppoſed to be, to import a regeneration, whereby the proſelyte is rendered a new man, and of a ſlave becomes free. The effect of it is, to cancel all former relations; ſo that thoſe who were before akin to the perſon, after the ceremony ceaſed to be ſo. It is to this ceremony Chriſt is ſuppoſed to have alluded, in his expreſſion to Nicodemus, that it was neceſſary he ſhould be born again, in order to become his diſciple.—The neceſſity of baptiſm to ſalvation, is grounded on thoſe two ſayings of our Saviour: *He that believeth, and is baptized, ſhall be ſaved*; and, *Except a man be born of water and of the Spirit, he cannot enter into the kingdom of God.*—The ancients did not generally think the mere want of baptiſm, where the procuring it was impracticable, excluded men abſolutely from the hopes of eternal ſalvation. Some few of them, indeed, are pretty ſevere upon infants dying without baptiſm; and ſome others ſeem alſo, in general terms, to deny eternal life to adult perſons dying without it: but when they interpret themſelves, and ſpeak more diſtinctly, they make ſome allowances, and except ſeveral caſes, in which the want of baptiſm may be ſupplied by other means. Such are martyrdom, which commonly goes by the name of *ſecond baptiſm in mens own blood*, in the writings of the ancients; becauſe of the power and efficacy it was thought to have, to ſave men by the inviſible baptiſm of the Spirit, without the external element of water. Faith, and repentance, were alſo eſteemed a ſupplement to the want of baptiſm, in ſuch catechumens as died while they were piouſly preparing themſelves for baptiſm. Conſtantly communicating with the church, was thought to ſupply the want of baptiſm, in perſons who had been admitted to communion, on a preſumption of their being duly baptized, though the contrary afterwards appeared. For infants dying without baptiſm, the caſe was thought more dangerous; as here, no perſonal faith, repentance, or the like, could be pleaded, to ſupply the defect, and waſh away original ſin: on this account, they who ſpoke moſt favourably of them, as Greg. Nazianzen, and Severus biſhop of Antioch, only aſſigned them a middle ſtate, neither in heaven nor hell. But the Latins, as St Auguſtin, Fulgentius, Marius Mercator, &c. who never received the opinion of a middle ſtate, concluded, as they could not be received into heaven, they muſt go to hell. Pelagius, and his followers, who denied original ſin, aſſerted, that they might be admitted to eternal life and ſalvation, though not to the kingdom of heaven; between which they diſtinguiſhed. Where the fault was not on the ſide of the child, nor his parents, but of the miniſter, or where any unavoidable accident rendered baptiſm abſolutely impoſſible, Hincmar, and others, make an exception, in holding the child ſaved without baptiſm.

Opinions concerning the neceſſity of baptiſm to ſalvation.

Of the time place, and ſubjects of baptiſm. The receiving baptiſm is not limited to any time, or age of life. Some contended for its being adminiſtered like circumciſion, preciſely on the eighth day, as Greg. Nazianzen; and others would have it deferred till the child is three years of age, and able to hear the myſtic words, and make anſwer thereto, though they do not underſtand them. In the canon law we find divers injunctions againſt deferring the baptiſm of infants beyond the 37th day, 30th day, and the 9th day; ſome of them under pecuniary forfeitures.

Salmaſius, and Suicerus from him, deliver it as authentic hiſtory, that for the two firſt ages, no one received baptiſm, who was not firſt inſtructed in the faith and doctrine of Chriſt, ſo as to be able to anſwer for himſelf, that he believed; becauſe of thoſe words, *He that believeth, and is baptized:* which, in effect, is to ſay, that no infant, for the firſt two ages, was ever admitted to Chriſtian baptiſm. But, afterwards, they own, that pædo-baptiſm came in, upon the opinion that baptiſm was neceſſary to ſalvation. But Voſſius, Dr Forbes, Dr Hammond, Mr Walker, and eſpecially Mr Wall, who has exactly conſidered the teſtimony and authority of almoſt every ancient writer that has ſaid any thing upon this ſubject, endeavour to evince, that infants were baptiſed even in the apoſtolical age. It is certain, Tertullian pleads ſtrongly againſt giving baptiſm to infants; which ſhows, at leaſt, that there was ſome ſuch practice in his age, though he diſapproved of it. It is certain, the ordinary ſubjects of this ſacrament in the firſt ages were converts from Judaiſm and Gentiliſm, who, before they could be admitted to baptiſm, were obliged to ſpend ſome time in the ſtate of catechumens, to qualify them to make their profeſſions of faith, and a Chriſtian life, in their own perſons: for, without ſuch perſonal profeſſions, there were ordinarily no admiſſion of them to the privilege of baptiſm.—Thoſe baptiſed in their ſick-beds were called *clinici*; and were held in ſome reproach, as not being reputed true Chriſtians. Hence ſeveral cenſures, in councils and eccleſiaſtical writers, of clinic baptiſm. This clinic baptiſm was not ſufficient to qualify the perſon, in caſe of recovery, for ordination. Some had their baptiſm put off by way of puniſhment, when they fell into groſs and ſcandalous crimes, which were to be expiated by a longer courſe of diſcipline and repentance. This was ſometimes 5, 10, 20 years, or more; even all their lives, to the hour of death, when their crimes were very flagrant.

In the earlieſt ages of the church, there was no ſtated time or place for the reception of baptiſm. Afterwards, Eaſter, Whitſuntide, and Epiphany, became ſolemn ſeaſons, out of which baptiſm was not adminiſtered, except in caſes of neceſſity. The catechumens, who were to receive it at theſe times, were called *competentes:* and to theſe it is that St Cyril addreſſes his catecheſes. In the apoſtolical age, and ſome time after, before churches and baptiſteries were generally erected, they baptized in any place where they had convenience; as John baptized in Jordan, and Philip baptized the eunuch in the wilderneſs, and Paul the jailor in his own houſe. But in after ages, baptiſteries were built adjoining to the church; and then rules were made, that baptiſm ſhould ordinarily be adminiſtered no where but in theſe buildings. Juſtinian, in one of his novels, refers to ancient laws, appointing that none of the ſacred myſteries of the church ſhould be celebrated in private houſes. Men might have private oratories for prayer in their own houſes; but they were not to adminiſter baptiſm or the euchariſt in them, unleſs by a particular licence from the biſhop of the place. Such baptiſms are frequently condemned in the ancient councils, under the name παραβαπτισματα, *baptiſms in private conventicles.*

Ancient ceremonies. As to the attendant ceremonies and manner of baptiſm in the ancient church: The perſon to be baptiſed, if

Baptiſm. if an adult, was firſt examined by the biſhop or officiating prieſt, who put ſome queſtions to him; as, firſt, Whether he abjured the devil and all his works; ſecondly, Whether he gave a firm aſſent to all the articles of the Chriſtian faith: to both which he anſwered in the affirmative. If the perſon to be baptized was an infant, theſe interrogatories were anſwered by his *ſponſores*, or godfathers. Whether the uſe of ſponſors was as old as the apoſtles days, is uncertain: perhaps it was not, ſince Juſtin Martyr, ſpeaking of the method and form of baptiſm, ſays not a word of them.—After the queſtions and anſwers, followed exorciſm; the manner and end of which was this; The miniſter laid his hands on the perſon's head, and breathed in his face, implying thereby the driving away or expelling of the devil from him, and preparing him for baptiſm, by which the good and holy ſpirit was to be conferred upon him.—After exorciſm, followed baptiſm itſelf: and firſt the miniſter, by prayer, conſecrated the water for that uſe. Tertullian ſays, "any waters may be "applied to that uſe; but then God muſt be firſt in-"vocated; and then the Holy Ghoſt preſently comes "down from heaven, and moves upon them, and ſanc-"tifies them." The water being conſecrated, the perſon was baptized "in the name of the Father, and of "the Son, and of the Holy Ghoſt;" by which, "dedication of him to the bleſſed Trinity, the perſon "(ſays Clemens Alexandrinus) is delivered from the "corrupt trinity, the devil, the world, and the fleſh." In performing the ceremony of baptiſm, the uſual cuſtom (except in clinical caſes, or where there was ſcarcity of water), was to immerſe and dip the whole body. Thus St Barnabas deſcribing a baptized perſon, ſays, "We go down into the water full of ſin "and filth, but we aſcend bearing fruit in our hearts." And this practiſe of immerſing the whole body was ſo general, that we find no exceptions made in reſpect either to the tenderneſs of infants, or the baſhfulneſs of the other ſex, unleſs in caſe of ſickneſs or other diſability. But to prevent any indecency, men and women were baptized apart. To which end, either the baptiſteries were divided into two apartments, one for the men, the other for the women, as Bingham has obſerved; or the men were baptized at one time, and the women at another, as is ſhown by Voſſius, from the *Ordo Romanus*, Gregory's *Sacramentarium*, &c. Add, that there was anciently an order of deaconeſſes, one part of whoſe buſineſs was to aſſiſt at the baptiſm of women. Theſe precautions, however, rather indicate a ſcrupulous attention to delicacy, than imply any indecency in the circumſtance of immerſion itſelf. From the candidates being immerſed, there is at leaſt no reaſon to infer that they were naked: The preſent Baptiſts never baptiſe naked, though they always immerſe. After immerſion, followed the unction; by which (ſays St Cyril) was ſignified, that they were now cut off from the wild olive, and were ingrafted into Chriſt, the true olive tree; or elſe to ſhow, that they were now to be champions for the goſpel, and were anointed thereto, as the old athletæ were againſt their ſolemn games. With this anointing was joined the ſign of the croſs, made upon the forehead of the perſon baptized; which being done, he had a white garment given him, to denote his being waſhed from the defilements of ſin, or in alluſion to that of the apoſtle, "as many as are "baptized into Chriſt have put on Chriſt." From this cuſtom the feaſt of Pentecoſt, which was one of the annual ſeaſons of baptiſm, came to be called *Whitſunday*, i. e. *White-ſunday*. This garment was afterwards laid up in the church, that it might be an evidence againſt ſuch perſons as violated or denied that faith which they had owned in baptiſm.—When the baptiſm was performed, the perſon baptized, according to Juſtin Martyr, "was received into the number of the faith-"ful, who then ſent up their public prayers to God, "for all men, for themſelves, and for thoſe who had "been baptized." Baptiſm.

The ordinary miniſters, who had the right of adminiſtering this ſacrament, that is, of applying the water to the body, and pronouncing the formula, were preſbyters or biſhops; though on extraordinary occaſions, laymen were admitted to perform the ſame.

As to the preſent form of adminiſtering baptiſm, the church of Rome uſes the following. When a child is to be baptiſed, the perſons who bring it wait for the prieſt at the door of the church, who comes thither in his ſurplice and purple ſtole, attended by his clerks. He begins with queſtioning the godfathers, whither they promiſe, in the child's name, to live and die in the true catholic and apoſtolic faith, and what name they would give the child. Then follows an exhortation to the ſponſors; after which the prieſt, calling the child by its name, aſks it as follows: *What doſt thou demand of the church?* The godfather anſwers, *Eternal life*. The prieſt goes on: *If you are deſirous of obtaining eternal life, keep God's commandments, thou ſhalt love the Lord thy God*, &c. After which he breathes three times into the child's face, ſaying, *Come out of this child, thou evil ſpirit, and make room for the Holy Ghoſt*. This ſaid he makes the ſign of the croſs on the child's forehead and breaſt, ſaying, *Receive the ſign of the croſs on thy forehead, and in thy heart*. Then taking off his cap, he repeats a ſhort prayer; and laying his hand gently on the child's head, repeats a ſecond prayer: which ended, he bleſſes ſome ſalt; and putting a little of it into the child's mouth, pronounces theſe words, *Receive the ſalt of wiſdom*. All this is performed at the church-door. The prieſt, with the godfathers and godmothers, coming into the church, and advancing towards the font, repeat the apoſtle's creed and the Lord's-prayer. Being come to the font, the prieſt exorciſes the evil ſpirit again; and taking a little of his own ſpittle, with the thumb of his right-hand, rubs it on the childs ears and noſtrils, repeating, as he touches the right ear, the ſame word (*Ephatha, be thou opened*) which our Saviour made uſe of to the man born deaf and dumb. Laſtly, they pull off its ſwaddling-cloaths, or ſtrip it below the ſhoulders, during which the prieſt prepares the oils, &c. The ſponſors then hold the child directly over the font, obſerving to turn it due eaſt and weſt; whereupon the prieſt aſks the child, *Whether he renounces the devil and all his works;* and the godfather having anſwered in the affirmative, the prieſt anoints the child between the ſhoulders in the form of a croſs. Then taking ſome of the conſecrated water, he pours part of it thrice on the child's head, at each perfuſion calling on one of the Perſons of the Holy Trinity. The prieſt concludes the ceremony of baptiſm with an exhortation.—The Romiſh church allows midwives, in caſes of danger to baptize a child before it is come entirely out of its mother's womb: where it is to be obſerved, that ſome part of the body Modern Forms. In the Church of Rome.

Baptiſm. of the child muſt appear before it can be baptized, and that it is baptized on the part which firſt appears: if it be the head, it is not neceſſary to rebaptize the child; but if only a foot or hand appears, it is neceſſary to repeat baptiſm. A ſtill-born child, thus baptized, may be buried in conſecrated ground.

In the Greek church. The Greek church differs from the Romiſh, as to the rite of baptiſm, chiefly, in performing it by immerſion, or plunging the infant all over in the water.

Engliſh form in the liturgy of K. Edward. The forms of adminiſtrating baptiſm among us being too well known to require a particular deſcription, we ſhall only mention one or two of the more material differences between the form, as it ſtood in the firſt liturgy of King Edward, and that in the Engliſh Common-Prayer book at preſent. Firſt, the form of conſecrating the water did not make a part of the office, in King Edward's liturgy, as it does in the preſent, becauſe the water in the font was changed, and conſecrated, but once a month. The form likewiſe itſelf was ſomething different from that now uſed; and was introduced with a ſhort prayer, that *Jeſus Chriſt, upon whom (when he was baptized) the Holy Ghoſt came down in the likneſs of a dove, would ſend down the ſame Holy Spirit, to ſanctify the fountain of baptiſm*; which prayer was afterwards left out, at the ſecond review.—By King Edward's firſt book, the miniſter is to dip the child in the water thrice; firſt, dipping the right-ſide; ſecondly, the left; the third time dipping the face toward the font. This trine immerſion was a very ancient practice in the Chriſtian church, and uſed in honour of the Holy Trinity; though ſome later writers ſay, it was done to repreſent the death, burial, and reſurrection, of Chriſt, together with his three days continuance in the grave. Afterwards, the Arians making an ill uſe of it, by perſuading the people that it was uſed to denote, that the three Perſons in the Trinity were three diſtinct ſubſtances, the orthodox left it off, and uſed one ſingle immerſion.

By the firſt common-prayer of King Edward, after the child was baptized, the godfathers and godmothers were to lay their hands upon it, and the miniſter was to put on him the white veſtment commonly called the *chryſome*, and to ſay, "Take this white veſture, as a token of the innocency, which, by God's grace, in this holy ſacrament of baptiſm, is given unto thee; and for a ſign, whereby thou art admoniſhed, ſo long as thou liveſt, to give thyſelf to innocence of living, that after this tranſitory life thou mayeſt be partaker of the life everlaſting. Amen." As ſoon as he had pronounced theſe words, he was to anoint the infant on the head, ſaying, "Almighty God, the Father of our Lord Jeſus Chriſt, who hath regenerated thee by water and the Holy Ghoſt, and hath given unto thee remiſſion of all thy ſins; may he vouchſafe to anoint thee with the unction of his Holy Spirit, and bring thee to the inheritance of everlaſting life. Amen." This was manifeſtly done in imitation of the practice of the primitive church.

The cuſtom of ſprinkling children, inſtead of dipping them in the font, which at firſt was allowed in caſe of the weakneſs or ſickneſs of the infant, has ſo far prevailed, that immerſion is at length quite excluded. What principally tended to confirm the practice of affuſion or ſprinkling, was, that ſeveral of our Proteſtant divines, flying into Germany and Switzerland during the bloody reign of queen Mary, and returning home when queen Elizabeth came to the crown, brought back with them a great zeal for the Proteſtant churches beyond ſea, where they had been ſheltered and received; and having obſerved, that at Geneva and ſome other places, baptiſm was adminiſtered by ſprinkling, they thought they could not do the church of England a greater piece of ſervice than by introducing a practice dictated by ſo great an oracle as Calvin. This, together with the coldneſs of our northern climate, was what contributed to baniſh entirely the practice of dipping infants in the font. Baptiſm.

Notions concerning the effects of baptiſm. Many different notions have been entertained concerning the effects of baptiſm, which it would be endleſs to enumerate.—The Remonſtrants and Socinians reduce baptiſm to a mere ſign of divine grace. The Romaniſts, on the contrary, exalt its power; holding that all ſin is entirely taken away by it; that it abſolutely confers the grace of juſtification, and conſequently grace *ex opere operato*. Some alſo ſpeak of an indelible character impreſſed on the ſoul by it, called *character dominicus* and *character regius*: but this is held, by others, a mere chimera; for that the ſpiritual character, conferred in regeneration, may eaſily be effaced by mortal ſins. Dodwell maintained, that it is by baptiſm the ſoul is made immortal; ſo that thoſe who die without it will not riſe again. It muſt be added, he reſtrains this effect to epiſcopal baptiſm alone. From the effects ordinarily aſcribed to baptiſm, even by ancient writers, it ſhould ſeem, that the ceremony is as much of heathen as of Jewiſh origin; ſince Chriſtians do not reſtrain the uſe of it, like the Jews, to the admiſſion of new members into the church, but hold, with the heathens, a virtue in it for the remitting and waſhing away ſins. The Bramins are ſtill ſaid to baptize with this latter view, at certain ſeaſons, in the river Ganges; to the waters whereof they have annexed a cleanſing or ſanctifying quality; and hence it is that they flock from all parts, even of Tartary, driven by the expectation of their being eaſed of their load of ſins. But, in this point, many Chriſtians ſeem to have gone beyond the folly of the heathens. It was only the ſmaller ſins of infirmity which theſe latter held to be expiable by waſhing; for crimes of a blacker dye, they allowed no water could efface them, no purgation could diſcharge them. The Chriſtian doctrine of a total remiſſion of ſins by baptiſm could not fail, therefore, to ſcandalize many among the heathens, and furniſhed Julian an occaſion of ſatiriſing Chriſtianity itſelf: "Whoever (ſays he) is guilty of rapes, murder, ſacrilege, or any abominable crime, let him be waſhed with water, and he will become pure and holy."

In the ancient church, baptiſm was frequently conferred on Jews by violence; but the church itſelf never ſeems to have allowed of force on this occaſion. By a canon of the fourth council of Toledo, it is expreſsly forbid to baptize any againſt their wills. That which looks moſt like force in this caſe, allowed by law, were two orders of Juſtinian; one of which appoints the heathens, and the other Samaritans to be baptized, with their wives and children and ſervants, under pain of confiſcation. By the ancient laws, baptiſm was not to be conferred on image-makers, ſtage-players, gladiators, *aurigæ* or public drivers, magicians,

Baptiſm. cians, or even ſtrolling beggars, till they quitted ſuch profeſſions. Slaves were not allowed the privilege of baptiſm without the teſtimony and conſent of their maſters; excepting the ſlaves of Jews, Heathens, and heretics, who were not only admitted to baptiſm, but, in conſequence thereof had their freedom. Voſſius has a learned and elaborate work *De Baptiſmo*, wherein he accurately diſcuſſes all the queſtions concerning baptiſm according to the doctrines of the ancients.

Bingham Orig. Eccl. l. 11. c. 5. §. 4. l. 8. c. 11. §. 17.

Baptism by Fire, ſpoken of by St John the Baptiſt, has occaſioned much conjecture. The generality of the fathers held, that believers, before they enter paradiſe, are to paſs through a certain fire, which is to purify them from all pollutions remaining on them unexpiated. Others, with St Baſil, underſtand it of the fire of hell; others, of that of tribulation and temptation. Others, with St Chryſoſtom, will have it denote an abundance of graces. Others ſuppoſe it to mean the deſcent of the Holy Ghoſt on the apoſtles, in form of fiery tongues. Laſtly, others maintain, that the word *fire* here is an interpolation: and that we are only to read the text, *He that ſhall come after me will baptize you with the Holy Ghoſt*. In reality it is not found in divers manuſcript copies of St. Matthew.

The ancient Seleucians and Hermians, underſtanding the paſſage literally, maintained, that material fire was neceſſary in the adminiſtration of baptiſm. But we do not find how, or to what part of the body they applied it, or whether they were ſatisfied with obliging the perſon baptized to paſs through the fire. Valentinus rebaptized all who had received water-baptiſm, and conferred on them the baptiſm of fire.

Bis docuit tingi, traduſtoque corpore flamma.
TERTULL. Carm. contr. Marc. l. 1.

Heracleon, cited by Clemens Alexandrinus, ſays, that ſome applied a red-hot iron to the ears of the perſon baptized, as if to impreſs ſome mark upon him.

Baptism of the Dead, a cuſtom which anciently prevailed among ſome people in Africa, of giving baptiſm to the dead. The third council of Carthage ſpeaks of it as a thing that ignorant Chriſtians were fond of. Gregory Nazianzen alſo takes notice of the ſame ſuperſtitious opinion prevailing among ſome who delayed to be baptized. In his addreſs to this kind of men, he aſks, whether they ſtaid to be baptized after death? Philaſtrius alſo notes it as the general error of the Montaniſts or Cataphrygians, that they baptized men after death. The practice ſeems to be grounded on a vain opinion, that, when men had neglected to receive baptiſm in their life-time, ſome compenſation might be made for this default by receiving it after death.

Baptiſm of the Dead, was alſo a ſort of vicarious baptiſm, formely in uſe, where a perſon dying without baptiſm, another was baptized in his ſtead.

St Chryſoſtom tells us, this was practiſed among the Marcionites with a great deal of ridiculous ceremony; which he thus deſcribes: After any catechumen was dead, they hid a living man under the bed of the deceaſed; then coming to the dead man, they aſked him, whether he would receive baptiſm? and he making no anſwer, the other anſwered for him, and ſaid, he would be baptized in his ſtead: and ſo they baptized the living for the dead.

Epiphanius aſſures us, the like was alſo practiſed among the Corinthians. This practice they pretended to found on the Apoſtle's authority; alledging that text of St. Paul for it, *If the dead riſe not at all, what ſhall they do who are baptized for the dead?* A text which has given occaſion to a great variety of different ſyſtems and explications. Boſius enumerates no leſs than nine different opinions among learned divines concerning the ſenſe of the phraſe *being baptized for the dead.* Baptiſm.

St Ambroſe and Walafred Strabo ſeem clearly of opinion, that the apoſtle had reſpect to ſuch a cuſtom then in being; and ſeveral moderns have given into the ſame opinion, as Baronius, Joſ. Scaliger, Juſtellus, and Grotius.

Several among the Roman-catholics, as Bellarmin, Salmeron Menochius, and a number of ſchoolmen, underſtand it of the baptiſm of tears, and penance, and prayers, which the living undergo for the dead; and thus alledge it as a proof of the belief of purgatory in St Paul's days.

Hypothetical BAPTISM, that formerly adminiſtered in certain doubtful caſes, with this formula: *If thou art baptized, I do not rebaptize; if thou art not, I baptize thee in the name of the Father*, &c. This ſort of baptiſm, enjoined by ſome ancient conſtitutions of the Engliſh church, is now fallen into diſuſe.

Solemn BAPTISM, that conferred at ſtated ſeaſons; ſuch, in the ancient church, were the *Paſchal baptiſm*, and that at Whitſuntide. This is ſometimes alſo called *general baptiſm*.

*Lay-*BAPTISM, we find to have been permitted by both the Common-prayer Books of King Edward and that of Queen Elizabeth, when an infant is in immediate danger of death, and a lawful miniſter cannot be had. This was founded upon the miſtaken notion of the impoſſibility of ſalvation without the ſacrament of baptiſm: but afterwards, when they came to have clearer notions of the ſacraments, it was unanimouſly reſolved in a convocation, held in the year 1575, that even private baptiſm, in a caſe of neceſſity was only to be adminiſtered by a lawful miniſter.

BAPTISM is alſo applied, abuſively, to certain ceremonies uſed in giving names to things inanimate.

The ancients knew nothing of the cuſtom of giving baptiſm to inanimate things, as bells, ſhips, and the like, by a ſuperſtitious conſecration of them. The firſt notice we have of this is in the Capitulars of Charles the Great, where it is only mentioned to be cenſured; but, afterwards, it crept into the Roman offices by degrees. Baronius carries its antiquity no higher than the year 968, when the greateſt bell of the church of Lateran was chriſtened by Pope John III. At laſt it grew to that ſuperſtitious height, as to be thought proper to be complained of in the *Centum Gravamina* of the German nation, drawn up in the public diet of the empire held at Nuremberg *anno* 1581; where (after having deſcribed the ceremony of baptizing a bell, with godfathers, who make reſponſes as in baptiſm, and give it a name, and clothe it with a new garment as Chriſtians were uſed to be clothed, and all this to make it capable of driving away tempeſts and devils), they conclude againſt it, not only a ſuperſtitious practice, but contrary to the Chriſtian religion, and a mere ſeduction of the ſimple people.

BAPTISM, in the ſea language, a ceremony in long voyages on board merchant ſhips, practiſed both on perſons

Baptiſmal of Baptiſts.

perſons and veſſels who paſs the tropic or line for the first time. The baptizing the veſſel is ſimple, and conſiſts only in waſhing them throughout with ſea-water; that of the paſſengers is more myſterious The oldeſt of the crew, that has paſt the tropic or line, comes with his face blacked, a groteſque cap on his head, and ſome ſea-book in his hand, followed by the reſt of the ſeamen dreſſed like himſelf, each having ſome kitchen utenſil in his hand, with drums beating; he places himſelf on a ſeat on the deck, at the foot of the main maſt. At the tribunal of this mock magiſtrate, each paſſenger not yet initiated, ſwears he will take care the ſame ceremony be obſerved, whenever he is in the like circumſtances: Then, by giving a little money by way of gratification, he is diſcharged with a little ſprinkling of water; otherwiſe he is heartily drenched with ſtreams of water poured upon him; and the ſhip-boys are incloſed in a cage, and ducked at diſcretion.—The ſeamen, on the baptizing a ſhip, pretend to a right of cutting off the beak-head, unleſs redeemed by the captain.

BAPTISMAL, ſomething belonging to baptiſm; thus we ſay baptiſmal vow, preſents, &c.

Baptismal Vow or *Covenant*, a profeſſion of obedience to the laws of Chriſt, which perſons in the ancient church made before baptiſm. It was an indiſpenſable part of the obligation on catechumens, before they were admitted to the ceremony of regeneration. It was made by turning to the Eaſt; for what myſtical reaſons, is not well agreed on.

Baptismal Preſents are in uſe in Germany, made by the ſponſors to the infant, conſiſting of money, plate, or even ſometimes fiefs of lands; which by the laws of the country are to be kept for the child till of age, the parents having only the truſt, not the right, of diſpoſing of them. An anonymous author has publiſhed a diſcourſe expreſs on this occaſion, intitled *De pecunia luſtrica*.

BAPTIST (John), Monnoyer, a painter of flowers and fruit, was born at Liſle in 1635, and educated at Antwerp, where he perfected himſelf in the knowledge of his art, and in his firſt years was intended for a painter of hiſtory: but having ſoon obſerved that his genius more ſtrongly inclined him to the painting of flowers, he applied his talents to thoſe ſubjects, and in that ſtyle became one of the greateſt maſters. His pictures are not ſo exquiſitely finiſhed as thoſe of Van Huyſum, but his compoſition and colouring are in a bolder ſtyle. His flowers have generally a remarkable freedom and looſeneſs, as well in the diſpoſition as in penciling; together with a tone of colouring that is lively, admirable, and nature itſelf. The diſpoſition of his objects is ſurpriſingly elegant and beautiful; and in that reſpect his compoſitions are eaſily known, and as eaſily diſtinguiſhed from the performances of others. He died in 1699.—He left a ſon, Anthony, who painted flowers in the ſame ſtyle and manner, and had great merit.

BAPTISTS, in eccleſiaſtical hiſtory, (from βαπτιζω, *I baptize*); a denomination of Chriſtians, diſtinguiſhed from other Chriſtians by their particular opinions reſpecting the mode and the ſubjects of baptiſm.

Inſtead of adminiſtering the ordinance by ſprinkling or pouring water, they maintain that it ought to be adminiſtered only by immerſion. Such, they inſiſt, is the meaning of the word βαπτιζω; ſo that a command to baptize is a command to immerſe. Thus it was underſtood by thoſe who firſt adminiſtered it. John the Baptiſt, and the apoſtles of Chriſt, adminiſtered it in Jordan and other rivers, and places where there was much water. Both the adminiſtrators and the ſubjects are deſcribed as going down into, and coming up again out of, the water; and the baptized are ſaid to be buried in baptiſm, and to be raiſed again: which language could not, they ſay, be properly adopted on ſuppoſition of the ordinance being adminiſtered in any other manner than by immerſion. Thus alſo they affirm it was in general adminiſtered in the primitive church. Thus it is now adminiſtered in the Ruſſian and Greek church: and thus it is, at this day, directed to be adminiſtered in the church of England, to all who are thought capable of ſubmitting to it in this manner. With regard to the ſubjects of baptiſm, the Baptiſts ſay, that this ordinance ought not to be adminiſtered to children or infants at all, nor to grown up perſons in general, but to adults only of a certain character and deſcription. Our Saviour's commiſſion to his apoſtles, by which Chriſtian baptiſm was inſtituted, is to go and teach all nations, baptizing them: that is, ſay they, not to baptize all they meet with; but firſt inſtruct them—to teach all nations, or to preach the goſpel to every creature—and whoever receives it, him to baptize in the name of the Father, and of the Son, and of the Holy Ghoſt. To ſuch perſons, and to ſuch only, baptiſm appears to have been adminiſtered by the apoſtles, and the immediate diſciples of Chriſt. They are deſcribed as repenting of their ſins, as believing in Chriſt, and as having gladly received the word. Without theſe qualifications, Peter acquaints thoſe who were converted by his ſermon, that he could not have admitted them to baptiſm. Philip holds the ſame language in his diſcourſe with the eunuch; and Paul treats Lydia, the jailor, and others, in the ſame manner. Without theſe qualifications, Chriſtians in general think it wrong to admit perſons to the Lord's ſupper; and, for the ſame reaſons, without theſe qualifications, at leaſt a profeſſion of them, the Baptiſts think it wrong to admit any to baptiſm. Wherefore they with-hold it, not only from the impenitently vicious and profane, and from infidels who have no faith; but alſo from infants and children, who have no knowledge, and are incapable of every action civil and religious. They further inſiſt, that all poſitive inſtitutions depend entirely upon the will and declaration of the inſtitutor; and therefore, that reaſoning by analogy from abrogated Jewiſh rites is to be rejected, and the expreſs commands of Chriſt reſpecting the mode and ſubjects of baptiſm ought to be our only rule.

Baptiſts.

The Baptiſts in England form one of the denominations of Proteſtant diſſenters. They ſeparate from the eſtabliſhment for the ſame reaſons as their brethren of the other denominations do; and from additional motives derived from their particular tenets reſpecting baptiſm. The conſtitution of their churches, and their modes of worſhip, are congregational or independent: in the exerciſe of which they are protected, in common with other diſſenters, by the act of toleration. Before this act, they were liable to pains and penalties as nonconformiſts, and often for their peculiar ſentiments.

Baptiſts, Baptiſtery.

ments as Baptiſts. A proclamation was iſſued out againſt them, and ſome of them were burnt in Smithfield in 1538. They bore a conſiderable ſhare in the perſecutions of the laſt and of the preceding centuries; and, as it ſhould ſeem, in thoſe of ſome centuries before; for there were ſeveral among the Lollards and the followers of Wickliff, who diſapproved of infant-baptiſm. There were many of this perſuaſion among the Proteſtants and reformers abroad. In Holland, Germany, and the North, they went by the names of ANABAPTISTS and MENNONITES: and, in Piedmont and the ſouth, they were found among the ALBIGENSES and WALDENSES. See the hiſtories of the Reformation, and the above articles in this Dictionary.

The *Baptiſts* ſubſiſt under two denominations, viz. the *Particular* or Calviniſtical, and the *General* or Arminian. The former is by far the moſt numerous. Some of both denominations allow of *mixed communion*, viz. of perſons who have been ſprinkled in their infancy, and therefore unbaptized in the view of the Baptiſts; others diſallow it: and ſome of them obſerve the ſeventh day of the week as the ſabbath, apprehending the law that enjoined it, not to have been repealed by Chriſt or his apoſtles. But a difference of opinion reſpecting theſe and other matters, is not peculiar to the Baptiſts: it is common to all Chriſtians, and to all bodies of men who think and judge for themſelves.

BAPTISTERY, in eccleſiaſtical writers, a place in which the ceremony of baptiſm is performed.

In the ancient church it was one of the exedræ or buildings diſtinct from the church itſelf: and conſiſted of a porch or anti-room where the perſons to be baptized made their confeſſion of faith, and an inner room where the ceremony of baptiſm was performed. Thus it continued till the ſixth century, when the baptiſteries began to be taken into the church-porch, and afterwards into the church itſelf.

The ancient baptiſteries were commonly called φωτισηρια, *photiſteria*, q. d. places of illumination; an appellation ſometimes given to baptiſm. Or they might have the name for another reaſon, becauſe they were the places of an illumination, or inſtruction, preceding baptiſm: for here the catechumens ſeem to have been trained up, and inſtructed in the firſt rudiments of the Chriſtian faith.

Thoſe baptiſteries were anciently very capacious; becauſe, as Dr Cave obſerves, the ſtated times of baptiſm returning but ſeldom, there were uſually great multitudes to be baptized at the ſame time: and then the manner of baptizing, by immerſion, or dipping under water, made it neceſſary to have a large font likewiſe. In *Venantius Fortunatus*, it is called *aula baptiſmatis*, the large hall of baptiſm; which was indeed ſo capacious, that we ſometimes read of councils meeting and ſitting therein. This hall, or chapel, was always kept ſhut during Lent, and the door ſealed up with the biſhop's ſeal, not to be opened till Maunday-Thurſday.

The baptiſtery was always reputed a ſacred place. In the Roman order, we find the ceremonies uſed in the conſecration of the baptiſteries: they were to be built of a round figure, and diſtinguiſhed with the image of St John the Baptiſt; over the baſon or font was a figure of a dove in gold or ſilver; to repreſent the Holy Ghoſt. Bar.

The name *baptiſtery* is ſometimes alſo given to a kind of chapel in a large church, which ſerved for the ſame office. It is an obſervation of ſome learned men, that anciently there was but one baptiſtery in a city, and that at the biſhop's church; and that afterwards they were ſet up in pariſh churches, with the ſpecial allowance however of the biſhop.

BAR, in a general ſenſe, denotes a ſlender piece of wood or iron, for keeping things cloſe together.

BAR, in courts of juſtice, an incloſure made with a ſtrong partition of timber, where the council are placed to plead cauſes. It is alſo applied to the benches where the lawyers or advocates are ſeated, becauſe anciently there was a bar to ſeparate the pleaders from the attorneys and others. Hence lawyers who are called to the bar, or licenſed to plead, are termed *barriſters*, an appellation equivalent to *licentiate* in other countries.

BAR, or *Barr*, (Latin *barra*, and in French *barre*), in a legal ſenſe, is a plea or peremptory exception of a defendant, ſufficient to deſtroy the plaintiff's action. And it is divided into bar to common intendment, and bar ſpecial; bar temporary, and perpetual. Bar to a common intendment is an ordinary or general bar, which uſually diſableth the declaration of the plaintiff; bar ſpecial is that which is more than ordinary, and falls out upon ſome ſpecial circumſtance of the fact as to the caſe in hand. Bar temporary is ſuch a bar as is good for the preſent, but may afterwards fail; and bar perpetual is that which overthrows the action of the plaintiff for ever.

BAR, in heraldry, an ordinary in form of the feſs, but much leſs. See HERALDRY.

BAR, in the menage, the higheſt part of that place of a horſe's mouth ſituated between the grinders and tuſhes, ſo that the part of the mouth which lies under and at the ſide of the bars retains the name of the gum. A horſe with ſenſible bars has a fine light mouth, with an even and firm appui. See APPUI.

To BAR a Vein, in farriery, is an operation performed upon the veins of the legs of a horſe and other parts, with intent to ſtop the malignant humours. It is done by opening the ſkin above it, diſengaging it, and tying it both above and below, and ſtriking between the two ligatures.

BAR, in muſic, a ſtroke drawn perpendicularly acroſs the lines of a piece of muſic, including between each two a certain quantity or meaſure of time, which is various as the time of the muſic is either triple or common. In common time, between each two bars is included the meaſure of four crotchets; in triple, three. The principal uſe of bars is to regulate the beating of time in a concert. The uſe of bars is not to be traced higher than the time when the Engliſh tranſlation of Adrian le Roy's book on the Tablature was publiſhed, *viz.* the year 1574; and it was ſometime after that before the uſe of bars became general. To come nearer to the point, Barnard's cathedral muſic, printed in 1641, is without bars: but bars are to be found throughout in the *Ayres and Dialogues* of Henry Lawes publiſhed in 1653; from whence it may be conjectured that we owe to Lawes this improvement.

Bar, Bara.

BAR, in hydrography, denotes a bank of ſand, or other matter, whereby the mouth of a river is in a manner choaked up.

The term *bar* is alſo uſed for a ſtrong beam wherewith the entrance of a harbour is ſecured: This is more commonly called *boom*.

BAR of a tavern or coffee-houſe, the place where the waiters attend to anſwer the calls of the cuſtomers.

BAR, among printers, denotes a piece of iron with a wooden handle, whereby the ſcrew of the preſs is turned in printing. See PRINTING.

BARS of Iron, are made of the metal of the ſows and pigs as they come from the furnace. Theſe paſs thro' two forges called the *finery* and the *chauſery*; where, undergoing five ſeveral heats, they are formed into bars.

BAR, a very ſtrong city of Podolia in Poland, upon the river Kiow. E. Long. 28. 30. N. Lat. 50. 6.

BAR, a duchy of France, bounded on the eaſt by Lorrain, on the north by Luxembourg, on the weſt by Champagne, on the ſouth by part of the ſame country and by Franche Compte. It is croſſed by the river Meuſe from north to ſouth, and watered by ſeveral other rivers, which render it very fertile. It is divided into four balliages, *viz.* Baſſilyni, Bar, St Michael, and Clermont. The chief towns are Bar-le-duc, Clermont, St Michael, Longuey, Pont a Mouſſon, and Stenay. In 1736, it was given to Staniſlaus then king of Poland.

BAR-le-Duc, the capital of the duchy of Bar, ſeated on the declivity of a hill. It is divided into the higher and lower town: the lower is watered by the rivulet Orney, which abounds with excellent trouts. The wines are excellent, and not inferior to thoſe of Champagne. E. Long. 5. 30. N. Lat. 48. 35.

BAR-le-Mont, a town of the French Netherlands, in Hainault, ſituated on the river Sombre. E. Long. 3. 40. N. Lat. 50. 10.

BAR ſur Auche, an ancient town of France, ſeated at the foot of a mountain. E. Long. 4. 50. N. Lat. 48. 14.

BAR ſur Seine, a town of France, in the duchy of Burgundy, ſeated between a mountain which covers it on the weſt, and the river Seine which runs on the eaſt. E. Long. 4. 30. N. Lat. 48. 5.

BAR-Maſter, among miners, the perſon who keeps the gage, or diſh, for meaſuring the ore.

BARA (anc. geog.), a ſmall iſland in the Adriatic, oppoſite to Brunduſium: the *Pharos* of Mela. Alſo a frith, or arm of the ſea of Britannia Secunda (Ptolemy); ſuppoſed to be the Murray-frith.

BARA, one of the Hebrides or Weſtern Iſlands of Scotland. It is a ſmall rock, only a quarter of a mile in circumference, being part of a chain called the *Long Iſland*, the whole cluſter appearing at low water as one iſland. Bara is altogether barren; but abounds with great numbers of ſea-fowl, ſuch as ſolon geeſe, guillamotes, puffins, &c.

BARA, the name of a feſtival celebrated with much magnificence at Meſſina, and repreſenting the aſſumption of the Virgin. The *bara*, though uſed as the general denomination of this feſtival, ſignifies more particularly a vaſt machine 50 feet high, at the top of which a young girl of 14, repreſenting the Virgin, ſtands upon the hand of an image of Jeſus Chriſt. Round him turn vertically, in a circle, 12 little children which repreſent the ſeraphims; below them, in another circle, which turns horizontally, are 12 more repreſenting the cherubims: below theſe a ſun turns vertically, with a child at the extremity of each of the four principal *radii* of his circle, who aſcend and deſcend with his rotation, yet ſtill ſtand upright. Below the ſun is the loweſt circle, about ſeven feet from the ground, in which 12 boys turn horizontally without interruption: theſe are intended for the twelve apoſtles, who are ſuppoſed to ſurround the tomb of the Virgin at the moment when ſhe aſcends into heaven. This complication of ſuperſtitious whirligigs may have already nearly turned the ſtomachs of ſome of our readers, or at leaſt rendered them ſqueamiſh. But think of the poor little cherubims, ſeraphims, and apoſtles, who are twirled about in this proceſſion! for, ſays Mr Houel, "ſome of them fall aſleep, many of them vomit, and ſeveral do ſtill worſe:" but theſe unſeemly effuſions are no drawback upon the edificationof the people; and nothing is more common than to ſee fathers and mothers ſoliciting with ardour for their boys and girls the pious diſtinction of puking at the bara. This machine is not drawn by aſſes or mules, but by a multitude of robuſt monks.

Barabinzians ‖ Baranwahr.

Houel's Deſcriptive Travels thro' Sicily, &c.

BARABINZIANS, a tribe of Tartars, living on both ſides the river Iris. They ſeem to derive their name from the *Barabaian* deſart, whoſe lakes ſupply them abundantly with fiſh, on which and their cattle they chiefly ſubſiſt. They have plenty of game and wild-fowl of every kind, particularly ducks and puffins. Moſt of them are heathens, but Mahometaniſm daily gains ground among them. Some of them pay tribute to the Empreſs of Ruſſia, and others to the Khan Taiſha.

BARACOA, a town in the north eaſt part of the iſland of Cuba. W. Long. 76. 10. N. Lat. 21. 5.

BARALIPTON, among logicians, a term denoting the firſt indirect mode of the firſt figure of ſyllogiſm. A ſyllogiſm in baralipton, is when the two firſt propoſitions are general, and the third particular, the middle term being the ſubject in the firſt propoſition, and the predicate in the ſecond. The following is of this kind:

B A. Every evil ought to be feared;
R A. Every violent paſſion is an evil;
LIP. Therefore ſomething that ought to be feared is a violent paſſion.

BARALLOTS, in church-hiſtory, a ſect of heretics at Bologna in Italy, who had all things in common, even their wives and children.—Their facility in complying with all manner of debauchery made them get the name *obedientes*, "compliers."

BARANCA DE MALAMBO, a town of Terra Firma in America, with a biſhop's ſee and a good haven. It is a place of great trade, and is ſeated on the river Magdaleine. W. Long. 75. 30. N. Lat. 11. 10.

BARANGI, officers among the Greeks of the lower empire. Cujas calls them Latin *protectores*, and others give them the name of *ſecurigeri*. It was their buſineſs to keep the keys of the city gates, where the emperor reſided.

BARANWAHR, a town of Lower Hungary, in a county of the ſame name, taken by the emperor of Germany from the Turks in 1684. It is ſeated between

Barathrum, Baratiere.

tween Buda and Belgrade, in E. Long. 20. 5. N. Lat. 46. 0.

BARATHRUM, in antiquity, a deep dark pit at Athens, into which condemned perſons were caſt headlong. It had ſharp ſpikes at the top, that no man might eſcape out; and others at the bottom, to pierce and torment ſuch as were caſt in.—Its depth and capaciouſneſs made it to be applied proverbially to a covetous perſon: to a glutton, called *Barathro* by the Romans (Lucretius, Horace), and *Barathrum* in the ſame ſenſe (Horace); and for a common proſtitute (Platus).

BARATIERE (Philip), a moſt extraordinary inſtance of the early and rapid exertion of mental faculties. This ſurpriſing genius was the ſun of Francis Baratiere, miniſter of the French church at Schwobach near Nuremberg, where he was born Jan. 10th 1721. The French was his mother-tongue, together with ſome words of High Dutch; but by means of his father inſenſibly talking Latin to him, it became as familiar to him as the reſt: ſo that, without knowing the rules of grammar, he at four years of age talked French to his mother, Latin to his father, High Dutch to the maid or neighbouring children; and all this without mixing or confounding the reſpective languages. About the middle of his fifth year he acquired Greek in like manner; ſo that in 15 months he perfectly underſtood all the Greek books in the Old and New Teſtament, which he readily tranſlated into Latin. When he was five years and eight months old, he entered upon Hebrew; and in three years time was ſo expert in the Hebrew text, that from a bible without points, he could give the ſenſe of the original in Latin or French; or tranſlate extempore the Latin or French verſions into Hebrew, almoſt word for word; and had all the Hebrew pſalms by heart. He compoſed at this time a dictionary of rare and difficult Hebrew words, with critical remarks and philological obſervations, in about 400 pages in 4to; and, about his tenth year, amuſed himſelf for twelve months with the Rabinical writers. With theſe he intermixed a knowledge of the Chaldaic, Syriac, and Arabic; and acquired a taſte for divinity and eccleſiaſtical antiquity, by ſtudying the Greek fathers, and councils of the firſt four ages of the church. In the midſt of theſe occupations, a pair of globes coming into his poſſeſſion, he could in 8 or 10 days time reſolve all the problems on them; and in about three months, in Jan. 1735, deviſed his project for the diſcovery of the longitude, which he communicated to the Royal Society at London and the Royal Academy of Sciences at Berlin. In June 1731, he was matriculated in the univerſity of Altorf; and at the cloſe of the year 1732, he was preſented by his father at the meeting of the reformed churches of the circle of Franconia; who, aſtoniſhed at his wonderful talents, admitted him to aſſiſt in the deliberations of the ſynod; and to preſerve the memory of ſo ſingular an event, it was ordered to be regiſtered in their acts. In 1734, the Margrave of Brandenburgh Anſpach granted this young ſcholar the uſe of whatever books he wanted from the Anſpach library, together with a penſion of 50 florins, which he enjoyed three years; and his father receiving a call to the French church at Stetin in Pomerania, young Baratiere was, on the journey, admitted maſter of arts, with univerſal applauſe, at the univerſity of Hall: at Berlin he was honoured with ſeveral converſations with the king of Pruſſia, and was received into the royal academy. Towards the cloſe of his life he acquired a taſte for medals, inſcriptions, and antiquities; metaphyſical inquiries, and experimental philoſophy, interveningoccaſionally between theſe ſtudies. He wrote ſeveral eſſays and diſſertations; made aſtronomical remarks, and laborious calculations; took great pains towards a hiſtory of the hereſies of the anti-trinitarians, and of the 30 years war in Germany: his laſt publication, which appeared in 1740, was on the ſucceſſion of the biſhops of Rome. The final work he engaged in, and for which he had gathered large materials, was *Inquiries concerning the Egyptian Antiquities*. But the ſubſtance of this blazing meteor was now almoſt exhauſted: he was always weak and ſickly; and died October 5. 1740, aged 19. years 8 months and 16 days. He publiſhed 11 different pieces, and left 26 manuſcripts on various ſubjects, the contents of which may be ſeen in his life written by M. Formey profeſſor of philoſophy at Berlin.

Baratz ‖ Barbadoes.

BARATZ (Turkiſh), letters-patent granted by the Turkiſh emperors to the Greek patriarch, biſhops, &c. for the exerciſe of their eccleſiaſtical functions. This *Baratz* gives the biſhops full power and authority to eſtabliſh and depoſe the inferior clergy, and all other religious perſons; to grant licences for marriages, and iſſue out divorces; to collect the revenues belonging to the churches; to receive the pious legacies bequeathed to them; in ſhort, to enjoy all the privileges and advantages belonging to their high ſtation: and all this (as it is expreſſed in the baratz itſelf), "according to the vain and idle ceremonies of the Chriſtians."

BARB, or Barbe, a horſe brought from Barbary. See Equus.

BARBA, in botany, a ſpecies of *pubes*, or down, with which the ſurface of ſome plants is covered. The term was invented by Linnæus; and by its application in the *Species Plantarum*, ſeems to ſignify a tuft or bunch of ſtrong hairs terminating the leaves. *Meſembryanthemum barbatum*, furniſhes an example.

The word is alſo often uſed in compoſition with ſome other, to form the trival names of ſeveral plants, as *barba jovis*, *barba capræ*, &c.

BARBACAN, or Barbican, an outer defence or fortification to a city or caſtle, uſed eſpecially as a fence to the city or walls; alſo, an aperture made in the wall of a fortreſs, to fire through upon the enemy. See Castle.

Barbacan is alſo uſed to denote a fort at the entrance of a bridge, or the outlet of a city, having a double wall with towers.

BARBADOES, the moſt eaſterly of all the Caribbee Iſlands, ſubject to Great Britain, and, according to the beſt geographers, lying between 59. 50. and 60. 2. of weſt longitude, and between 12. 56. and 13. 16. of north latitude. Its extent is not certainly known: the moſt general opinion is, that it is 25 miles from north to ſouth, and 15 from eaſt to weſt; but theſe menſurations are ſubject to ſo many difficulties and uncertainties, that it will perhaps convey a more adequate idea of this iſland to tell the reader than in reality it does not contain above 107,000 acres. The climate is hot, but not unwholeſome, the heat being qualified by ſea-

Barbadoes. sea-breezes; and a temperate regimen renders this island as safe to live in as any climate south of Great Britain; and, according to the opinion of many, as even Great Britain itself. This island has on its east side two streams that are called *rivers*, and in the middle is said to have a bituminous spring which sends forth a liquor like tar, and serves for the same uses as pitch or lamp-oil. The island abounds in wells of good water, and has several reservoirs for rain-water. Some parts of the soil are said to be hollowed into caves, some of them capable of containing 300 people. These are imagined to have been the lurking-places of runaway negroes, but may as probably be natural excavations. The woods that formerly grew upon the island have been all cut down, and the ground converted into sugar plantations. When those plantations were first formed, the soil was prodigiously fertile, but has since been worn out, insomuch, that about the year 1730, the planters were obliged to raise cattle for the sake of their dung, by which means the profit of their plantations was reduced to less than a tenth of its usual value. Notwithstanding the smallness of Barbadoes, its soil is different; being in some places sandy and light, in others rich, and in others spongy; but all of it is cultivated according to its proper nature, so that the island presents to the eye the most beautiful appearance that can be imigined. Oranges and lemons grow in Barbadoes in great plenty, and in their utmost perfection. The lemon juice here has a peculiar fragrancy. The citrons of Barbadoes afford the best drams and sweetmeats of any in the world, the Barbadoes ladies excelling in the art of preserving the rhind of the citron fruit. The juice of the limes, or dwarf lemons, is the most agreeable souring we know, and great quantities of it have of late been imported into Britain and Ireland. The pine apple is also a native of Barbadoes, and grows there to much greater perfection than it can be made to do in Europe by any artificial means. A vast number of different trees peculiar to the climate are also found to flourish in Barbadoes in great perfection; such as the aloe, mangrove, calabash, cedar, cotton, mastic, &c. Here likewise are produced some sensitive plants, with a good deal of garden stuff, which is common in other places. In short, a native of the finest, the richest, and most diversified country in Europe, can hardly form an idea of the variety of delicious and at the same time nutritive vegetable productions with which this island abounds.

When Barbadoes was first discovered by the English, few or no quadrupeds were found upon it, except hogs, which had been left there by the Portuguese. For convenience of carriage to the sea-side, some of the planters at first procured camels; which undoubtedly would in all respects have been preferable to horses for their sugar and other works; but the nature of the climate disagreeing with that animal, it was found impossible to preserve the breed. They then applied for horses to Old and New England: from the former they had those that were fit for shew and draughts; from the latter those that were proper for mounting their militia, and for the saddle. They had likewise some of an inferior breed from Curassao, and other settlements. They are reported to have had their first breed of black cattle from Bonavista and the isle of May; they now breed upon the island, and often do the work of horses. Their asses are very serviceable in carrying burdens to and from the plantations. The hogs of Barbadoes are finer eating than those of Britain, but the few sheep they have are not near so good. They likewise have goats, which when young are excellent food. Racoons and monkies are also found here in great abundance. A variety of birds are produced on Barbadoes, of which the humming bird is the most remarkable. Wild fowl do not often frequent this island; but sometimes teal are found near their ponds. A bird which they call the *man of war*, is said to meet ships at 20 leagues from land, and their return is, to the inhabitants, a sure sign of the arrival of these ships. When the wind blows from the south and south-west, they have flocks of curlews, plovers, snipes, wild pigeons, and wild ducks. The wild pigeons are very fat and plentiful at such seasons, and rather lager than those of England. The tame pigeons, pullets, ducks, and poultry of all kinds, that are bred at Barbadoes, have also a fine flavour, and are accounted more delicious than those of Europe. Their rabbits are scarce; they have no hares; and if they have deer of any kind, they are kept as curiosities. The insects of Barbadoes are not venomous, nor do either their snakes or scorpions ever sting. The musketoes are troublesome, and bite; but are more tolerable in Barbadoes than on the continent. Various other insects are found on the island, some of which are troublesome, but in no greater degree than those that are produced by every warm summer in England. Barbadoes is well supplied with fish; and some caught in the sea surrounding it are almost peculiar to itself; such as the parrot-fish, snappers, grey cavallos, terbums, and coney-fish. The mullets, lobsters, and crabs, caught here are excellent; and the green turtle is perhaps the greatest delicacy that ancient or modern luxury can boast of. At Barbadoes this delicious shell-fish seldom sells for less than a shilling a pound, and often for more. There is found in this island a kind of land crab which eats herbs wherever it can find them, and shelters itself in houses and hollows of trees. According to report, they are a shell-fish of passage; for in March they travel to the sea in great numbers. See CANCER. Barbadoes.

The inhabitants may be reduced to three classes, viz. the masters, the white servants, and the blacks. The former are either English, Scots, or Irish: but the great encouragement given by government to the peopling of this and other West Indian islands, induced some Dutch, French, Portuguese, and Jews, to settle among them with their estates; by which, after a certain time, they acquire the rights of naturalization in Great Britain. The white servants, whether by covenant or purchase, lead more easy lives than the day-labourers in England; and when they come to be overseers, their wages and other allowances are considerable. As to the treatment of the negro slaves in this and the other islands, that falls to be spoken of under the articles NEGRO, SLAVE, WEST-INDIES; which see. The manners of the white inhabitants, in general, are the same as in most polite towns and countries in Europe. The capital of the island is called *Bridge-Town*; see that article.

As the history of this island furnishes no very remarkable events, the following short hints concerning it may suffice.

When

Barbadoes, Barbara,

When the Engliſh, ſome time after the year 1625, firſt landed here, they found it the moſt ſavage and deſtitute place they had hitherto viſited. It had not the leaſt appearance of ever having been peopled even by ſavages. There was no kind of beaſts of paſture or of prey, no fruit, no herb, no root fit for ſupporting the life of man. Yet as the climate was ſo good, and the ſoil appeared fertile, ſome gentlemen of ſmall fortune in England reſolved to become adventurers thither. The trees were ſo large, and of a wood ſo hard and ſtubborn, that it was with great difficulty they could clear as much ground as was neceſſary for their ſubſiſtence. By unremitting perſeverance, however, they brought it to yield them a tolerable ſupport; and they found that cotton and indigo agreed well with the ſoil; and that tobacco, which was beginning to come into repute in England, anſwered tolerably. Theſe proſpects, together with the ſtorm between the king and parliament, which was beginning to break out in England, induced many new adventurers to tranſport themſelves into this iſland. And what is extremely remarkable, ſo great was the increaſe of people in Barbadoes, 25 years after its firſt ſettlement, that in 1650 it contained more than 50,000 whites, and a much greater number of negro and Indian ſlaves. The latter they acquired by means not at all to their honour: for they ſeized upon all thoſe unhappy men, without any pretence, in the neighbouring iſlands, and carried them into ſlavery; a practice which has rendered the Caribbee Indians irreconcilable to them ever ſince. They had begun a little before this to cultivate ſugar, which ſoon rendered them extremely wealthy. The number of ſlaves, therefore, was ſtill augmented; and in 1676 it is ſuppoſed that their number amounted to 100,000, which, together with 50,000 whites, make 150,000 on this ſmall ſpot: a degree of population unknown in Holland, in China, or any other part of the world moſt renowned for numbers. At this time Barbadoes employed 400 ſail of ſhips, one with another, of 150 tons in their trade. Their annual exports in ſugar, indigo, ginger, cotton, and citron-water, were above L.350,000, and their circulating caſh at home was L.200,000. Such was the increaſe of population, trade, and wealth, in the courſe of 50 years. But ſince that time this iſland has been much on the decline; which is to be attributed partly to the growth of the French ſugar-colonies, and partly to the Engliſh eſtabliſhments in the neighbouring iſles. Their numbers at preſent are ſaid to be 20,000 whites, and 100,000 ſlaves. Their commerce conſiſts of the ſame articles as formerly, though they deal in them to leſs extent.

Barbadoes-Tar, a mineral fluid of the nature of the thicker fluid bitumens, of a nauſeous bitteriſh taſte, very ſtrong and diſagreeable ſmell, found in many parts of America trickling down the ſides of the mountains, and ſometimes floating on the ſurface of the waters. It has been greatly recommended in coughs, and other diſorders of the breaſt and lungs.

BARBARA, among logicians, the firſt mode of the firſt figure of ſyllogiſms. A ſyllogiſm in barbara is one whereof all the propoſitions are univerſal and affirmative; the middle term being the ſubject of the firſt propoſition, and attribute in the ſecond.

Barbarian ‖ Barbaroſſa.

Examp. Bar. Every wicked man is miſerable;
Ba. All tyrants are wicked men;
Ra. Therefore all tyrants are miſerable.

BARBARIAN, a name given by the ancient Greeks and Romans to all who were not of their own country, or were not initated in their language, manners, and cuſtoms.—In this ſenſe, the word ſignified with them no more than foreigner; nor ſignifying, as among us, a wild, rude, or uncivilized perſon.

BARBARISM, in a general ſenſe, a rudeneſs of language or behaviour.

Barbarism, in grammar, an offence againſt the purity of ſtyle or language; or an ungrammatical way of ſpeaking or writing, contrary to the true idiom of any particular language.

BARBAROSSA (Aruch, and Hayradin), two famous corſairs, the ſons of a potter in the iſle of Leſbos, who, turning pirates, carried on their depredations with ſuch ſucceſs and conduct, that they were ſoon poſſeſſed of 12 galleys beſide ſmaller veſſels. Of this fleet Aruch the elder brother, called *Barbaroſſa* from the redneſs of his beard, was admiral, and Hayradin the ſecond in command: they called themſelves the *friends of the ſea*, and the *enemies of all who ſailed upon it*; and their names became terrible from the ſtraits of Dardanelles to thoſe of Gibraltar. With ſuch a power they wanted an eſtabliſhment; and the opportunity of ſettling themſelves offered in 1516, by the inconſiderate application of Eutemi king of Algiers to them for aſſiſtance againſt the Spaniards. Aurch, leaving his brother to command the fleet, carried 5000 men to Algiers, where he was received as their deliverer; and ſecretly murdering the prince he came to aid, cauſed himſelf to be proclaimed king in his ſtead. To this uſurpation he added the conqueſt of Tremecen; when his exploits and piracies induced the emperor Charles V. to furniſh the Marquis de Gomarez governor of Oran with troops to ſuppreſs him; by whom he was defeated and killed near Tremecen. His brother Hayradin, known alſo by the name of *Barbaroſſa*, aſſumed the ſceptre at Algiers with the ſame abilities, and with better fortune; for the Spaniards, ſufficiently employed in Europe, giving him no diſturbance, he regulated the interior police of his kingdom with great prudence, carried on his naval operations with vigour, and extended his conqueſts on the continent of Africa. He put his dominions under the protection of the Grand Signior, Solyman the Magnificent; and obtained the command of the Turkiſh fleet. With ſo powerful a protector, he acquired the kingdom of Tunis in a manner ſimilar to that by which his brother gained Algiers. Since the time of the Barbaroſſas, Algiers has been underſtood to be dependent on the Porte; but this dependence is now little more than merely nominal.

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